

**DRAFT**

**Water Quality Criteria Report for Oxyfluorfen**

Phase III: Application of the pesticide water quality criteria  
methodology



Prepared for the Central Valley Regional Water Quality Control Board

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*June 2016*

## **Disclaimer**

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## List of acronyms and abbreviations

AF	Assessment factor
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
BMF	Biomagnification Factor
CAS	Chemical Abstract Service
CDFG	California Department of Fish and Game
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CVRWQCB	Central Valley Regional Water Quality Control Board
DPR	Department of Pesticide Regulation
EC <sub>x</sub>	Concentration that affects x% of exposed organisms
FDA	Food and Drug Administration
FT	Flow-through test
IC <sub>x</sub>	Inhibition concentration; concentration causing x% inhibition
ICE	Interspecies Correlation Estimation
IUPAC	International Union of Pure and Applied Chemistry
K	Interaction Coefficient
K <sub>H</sub>	Henry's law constant
K <sub>ow</sub>	Octanol-Water partition coefficient
K <sub>p</sub> or K <sub>d</sub>	Solid-Water partition coefficient
LC <sub>x</sub>	Concentration lethal to x% of exposed organisms
LD <sub>x</sub>	Dose lethal to x% of exposed organisms
LL	Less relevant, Less reliable study
LOEC	Lowest-Observed Effect Concentration
LR	Less relevant, Reliable study
MATC	Maximum Acceptable Toxicant Concentration
N	Not relevant or Not reliable study
n/a	Not applicable
NOEC	No-Observed Effect Concentration
NR	Not reported
OECD	Organization for Economic Co-operation and Development
pK <sub>a</sub>	Acid dissociation constant
RL	Relevant, Less reliable study
RR	Relevant and Reliable study
S	Static test
SMAV	Species Mean Acute Value
SR	Static renewal test
SSD	Species Sensitivity Distribution
TES	Threatened and Endangered Species
US	United States
USEPA	United States Environmental Protection Agency

# 1 Introduction

A methodology for deriving freshwater water quality criteria for the protection of aquatic life was developed by the University of California - Davis (TenBrook et al. 2009a). The need for a methodology was identified by the California Central Valley Regional Water Quality Control Board (CVRWQCB 2006) and findings from a review of existing methodologies (TenBrook & Tjeerdema 2006, TenBrook et al. 2009b). The UC-Davis methodology is currently being used to derive aquatic life criteria for several pesticides of particular concern in the Sacramento River and San Joaquin River watersheds. The methodology report (TenBrook et al. 2009a) contains an introduction (Chapter 1); the rationale of the selection of specific methods (Chapter 2); detailed procedure for criteria derivation (Chapter 3); and a criteria report for a specific pesticide (Chapter 4). This criteria report for oxyfluorfen describes, section by section, the procedures used to derive criteria according to the UC-Davis methodology. Also included are references to specific sections of the methodology procedure detailed in Chapter 3 of the report so that the reader can refer to the report for further details (TenBrook et al. 2009a).

## 2 Basic Information

Chemical: Oxyfluorfen (Fig. 1)

CAS: 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene

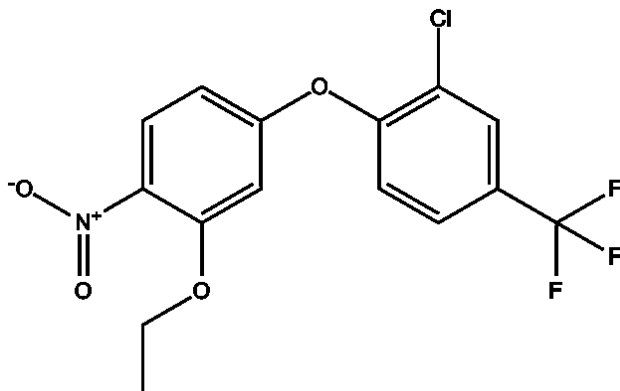
CAS Number: 42874-03-3

USEPA PC Code: 111601

CA DPR Chem Code: 1973

IUPAC: 2-chloro- $\alpha,\alpha,\alpha$ -trifluoro-p-tolyl

Chemical Formula:  $C_{15}H_{11}ClF_3NO_4$



**Figure 1 Structure of oxyfluorfen**

(source: <http://wtt-pro.nist.gov/wtt-pro/index.html?cmp=2-chloro-1~3-ethoxy-4-nitrophenoxy~4~trifluoromethyl~benzene#2-chloro-1~3-ethoxy-4-nitrophenoxy~4~trifluoromethyl~benzene/A;0,0,508,424;help,about/aa1;0,38,1004,424/>)

Trade names: Goal; Koltar; RH-2915; Oxyfluorfene; RH 2915; Oxyfluorofen; Galigan; Koltar; Oxygold; Oxyfluorfen

### 3 Physical-Chemical Data

#### Molecular Weight

361.70120964 (<http://www.cdms.net/LDat/l dB45000.pdf>)

#### Density

1.53 g/mL (PPDB 2008)

#### Water Solubility

0.1958 mg/L at 25°C (USEPA 2015a)

0.116 mg/L at 25°C (USEPA 2015a)

0.116 mg/L at 25°C (USDA/ARS1995)

0.116 mg/L at 20°C (PPDB 2015)

0.1 mg/L (Kidd & James 1991)

0.1 mg/L (WSSA 1989)

**Geometric mean:** 0.1768 mg/L

#### Melting Point

156.08°C (USEPA 2015a)

85.3°C (PPDB 2015)

**Geometric mean:** 115.38 °C

#### Vapor Pressure

0.0267 mPa at 25°C (Anatra-Cordone et al. 2005)

0.026 mPa at 25°C (PPDB 2015)

#### Henry's constant ( $K_H$ )

$2.38 \times 10^{-2} \text{ Pa m}^3 \text{ mol}^{-1}$  (USEPA 2015a)

$2.382 \times 10^{-2} \text{ Pa m}^3 \text{ mol}^{-1}$  (PPDB 2015)

**Geometric mean:**  $2.381 \times 10^{-2} \text{ Pa m}^3 \text{ mol}^{-1}$

#### Organic Carbon Sorption Partition Coefficients ( $K_{oc}$ )

All values from Anatra-Cordone, et al. (2005).

2,891 sand

32,381 silty clay loam

100,000 "recommended value"

**Geometric mean: 21,076**

#### Log $K_{ow}$

All values referenced from the BioByte Bio-Loom program (2015)

4.47 (Anatra-Cordone et al. 2005)



4.86 (PPDB 2015)  
 5.03 (Donovan & Pescatore 2002)  
 4.73 (Nandihalli et al. 1993)  
 4.47 (Tomlin 1997)  
 4.57 (Wu et al. 1998)  
**Geometric mean: 4.68**

#### Bioconcentration Factor

Table 1 Bioconcentration factors (BCF) for oxyfluorfen FT: flow-through, SR: static renewal, S: static, NR: not reported; values are on a wet weight basis and are not lipid-normalized.			
Species	BCF	Exposure	Reference
NR	613.6	NR	USEPA 2015a
NR	1637	NR	PPDB 2015

#### Environmental Fate

Table 2 Oxyfluorfen hydrolysis and photolysis and other degradation. (NR: not reported, WHC: % water holding capacity).					
	Half- life (d)	Water	Temp (°C)	pH	Reference
Hydrolysis	Stable	NR	NR	5-9	Tomlin 2004
	Stable	Aqueous buffer	25 & 45	4, 7, 10	Garstka 1977
Aqueous Photolysis	5 h	Milli-Q	NR, ambient outdoor	NR	Ying et al. 1999
	2.34-3.0 d	Aqueous solution	25	7	Reibach 1991
	3 d	NR	NR	NR	Anatra-Cordone et al. 2005
	3.7 d	Aqueous buffer	21	7	Kesterson et al. 1989a
	5.4 d	Aqueous buffer	21	7	Kesterson et al. 1989b
Biodegradation (anaerobic)	~28 d* ~18 d**	*Estuarine **Estuarine sediment slurry	25	NR, maintained at field value	Walker et al. 1988 c
	3.5 d*, water phase	*River sediment slurry	20	8* 7.7**	Mamouni 2002

	3.9 d**, water phase	**Lake sediment slurry			
	Stable	*Clay loam, flooded/aerated **Clay loam, flooded/non- aerated	21	8.2* 7.8**	Peirson & Fisher 1978
	554-603 d	Sandy loam, aerobic 30 d then flooded 60 d	25	NR	Korsch & Doran 1988
Biodegradation (aerobic)	77 d* 68 d** 69 d***	Soils held at 40-50% WHC *Sandy loam **Loamy sand/Sandy loam ***Clay loam	20	7.4* 7.4** 6.5***	Gaaauw 2003
	117 d* 262 d**	Irrigated field soils *Sandy loam **Loam	NR, ambient field conditions	6.9* 7.1**	Reibach 1989
	Stable, green house conditions	Sandy loam, 12.5 WHC Silt loam, 15.6 WHC	10	5.5	Fisher, no date

## 4 Human and Wildlife Dietary Values

There are no FDA action levels for oxyfluorfen in food (USFDA 2000) and there are no EPA pesticide tolerances set for any aquatic species (USEPA 1995).

### Wildlife LC<sub>50</sub> values (dietary) for animals with significant food sources in water

The US EPA Environmental Risk Assessment for the Reregistration of Oxyfluorfen (USEPA 2002) states that oxyfluorfen is practically nontoxic to birds for acute exposures but could potentially affect birds on a subchronic and chronic basis. No LC<sub>50</sub> data was available for mallard duck.

### Wildlife dietary NOEC values for animals with significant food sources in water

A 20-week reproduction study for mallard duck (*Anus platyrhynchos*) resulted in a dietary NOEC value of 500 mg/kg feed (Frey et al. 2003).

## 5 Ecotoxicity Data

Approximately 34 original studies on the effects of oxyfluorfen on aquatic life were identified and reviewed. In the review process, many parameters were rated for documentation and acceptability for each study, including, but not limited to: organism source and care, control description and response, chemical purity, concentrations tested, water quality conditions, and statistical methods (see Tables 3.6, 3.7, 3.8 in TenBrook et al. 2009a). Single-species effects studies that were rated as relevant (R) or less relevant (L) according to the method (Table 3.6) were summarized in data summary sheets. Information in these summaries was used to evaluate each study for reliability, using the rating systems described in the methodology (Tables 3.7 and 3.8, section 3-2.2, TenBrook et al. 2009a), to give a reliability rating of reliable (R), less reliable (L), or not reliable (N).

Studies of the effects of oxyfluorfen on mallard ducks were rated for reliability using the terrestrial wildlife evaluation. Mallard studies rated as reliable (R) or less reliable (L) were used to consider bioaccumulation. Only one study for mallard duck rating RR was located in the literature.

Copies of completed summaries for all aquatic studies are included in the Appendix of this report. All data rated as acceptable (RR) or supplemental (RL, LR, LL) for criteria derivation are summarized in Tables 3 - 9, found at the end of this report. Acceptable studies rated as RR are used for numeric criteria derivation, while supplemental studies rated as RL, LR or LL are used for evaluation of the criteria to check that they are protective of particularly sensitive species and threatened and endangered species. These considerations are reviewed in section 12 and 14 of this report, respectively. Studies that were rated not relevant (N) or not reliable (RN or LN) were not used for criteria derivation.

### Evaluation of aquatic animal data

Using the data evaluation criteria (section 3-2.2, TenBrook et al. 2009a), one acute study yielding one toxicity value from one taxon was judged reliable and relevant for acute criterion derivation (Table 3). Four acute toxicity animal values for four taxa from four studies were rated RL, LL, or LR and were used as supplemental information for evaluation of the derived acute criteria in the Sensitive Species section 12 (Table 4). A single chronic animal toxicity value from one study was rated RR (Table 6). Eleven chronic toxicity animal values from four studies were rated RL, LL, or LR (Table 9).

### Evaluation of aquatic plant data

Plant data were used to derive the chronic criterion instead of chronic animal data because oxyfluorfen is an herbicide and plants are the most sensitive taxa (section 3-4.3, TenBrook et al. 2009a). All plant studies were considered chronic because the typical endpoints of growth or reproduction are inherently chronic. Eight studies yielding forty five plant toxicity values were rated RR for the chronic criterion derivation (Tables 6a

and 7). Supplemental information for the derived chronic criteria includes four plant toxicity values from one study (Table 8).

Plant studies are more difficult to interpret than animal data because a variety of endpoints may be used, but the significance of each one is less clear. In this methodology, only endpoints of growth or reproduction (measured by biomass) and tests lasting at least 24-h had the potential to be rated highly and used for criteria calculation, which is in accordance with standard methods (ASTM 2007a, 2007b; USEPA 1996). The plant studies were rated for quality using the data evaluation criteria described in the methodology (section 3-2.2, TenBrook et al. 2009a).

There are several endpoints listed in the tables for plant data. The endpoints are explained here for clarity and the description includes if the endpoint is clearly linked to survival, growth, or reproduction.

**Growth inhibition:** All of these endpoints are relative to a control growth measurement. Depending on the plant it may have been measured by direct cell counts with a hemacytometer, cell counts with a spectrophotometer, cell counts with an electronic particle counter, chlorophyll concentration measured by absorbance, turbidity measured by absorbance, or number of fronds (*Lemna spp.*). In all cases, growth of exposed samples was compared statistically to controls.

**Growth Rate:** Biomass of macrophytes was measured before and after exposure to calculate a growth rate as (final mass-initial mass)/initial mass x 100. This endpoint is very similar to growth inhibition, except it is expressed as a positive effect, while growth inhibition is expressed a negative effect. In all cases, growth rate of exposed samples was compared statistically to controls.

**Area Under Growth Curve:** Plant growth was measured over time and the integral was taken from  $t_0$  to  $t_x$ . This endpoint is a measure of the effect of oxyfluorfen on net growth, accounting for all periods of growth regardless of growth rate.

## 6 Data Reduction

Acceptable chronic data that were reduced, and the reasons for their exclusion, are shown in Table 7. Reasons for reduction of data included: a test with a more sensitive exposure duration for the same species was available, flow-through tests are preferred over static tests, a test with a more sensitive life-stage of the same species was available, and tests with more sensitive endpoints were available. There were no acceptable acute data that were reduced. The final acute animal, chronic plant, and chronic animal data sets are shown in Tables 3, 5, and 6, respectively.

## 7 Acute Criterion Calculation

An acute criterion could not be calculated for oxyfluorfen. Only one acute toxicity value was available; however, it did not meet the requirements for criteria derivation

using an Assessment Factor (AF). The methodology states that at least one of the acute data must be from one of three specific species in the family Daphniidae or a criterion cannot be derived (section 3-3.3, TenBrook et al. 2009a). The single acute value available was an LC<sub>50</sub> of 200 µg/L for bluegill (*Lepomis macrochirus*) from the Centrarchidae family (Table 3), and is therefore not acceptable for the AF procedure.

## 8 Chronic Criterion Calculation

Oxyfluorfen is an herbicide and the chronic data in Tables 5 and 6 demonstrate that plants are the most sensitive taxa; therefore, the procedure for derivation of the chronic criterion of an herbicide was followed (section 3-4.3, TenBrook et al. 2009a). The chronic criterion is derived to be protective of plants, but will also likely be protective of animals, which are less sensitive to oxyfluorfen. Acceptable chronic toxicity values were not available for five different species of vascular plants or alga, so a distribution could not be fit to the available toxicity data (part 1, section 3-4.3, TenBrook et al. 2009a). The methodology instructs that in the absence of acceptable data to fit a distribution, the chronic criterion is equal to the lowest NOEC from an important alga or vascular aquatic plant species that has measured concentrations and a biologically relevant endpoint (part 2, section 3-4.3, TenBrook et al. 2009a). Acceptable toxicity data for the aquatic plant *Lemna gibba* (Roshon 2002b) is shown in Table 5, and the NOEC value reported for this species serves as the chronic criterion.

Chronic criterion = 0.14 µg/L

## 9 Water Quality Effects

### 9.1 Bioavailability

No studies were found concerning the bioavailability of oxyfluorfen.

### 9.2 Mixtures

No studies were located in the literature that tested the effects of oxyfluorfen in combination with other biocides of any kind (herbicides, fungicides, pesticides) in aquatic systems.

Oxyfluorfen is often mixed with nonionic surfactant as a wetting agent to aid in the spreading and absorption of the herbicide onto foliage. No studies were located that tested the effects of these adjuvants with oxyfluorfen specifically. However, Krogh et al. (2003) reviewed the toxic effects of some nonionic ethoxylate surfactants to a variety of aquatic organisms. Toxicity to phytoplanktonic species such as *R. subcapitata*, and crustaceans such as *D. magna*, increases with decreasing branching and increasing alkyl chain length. Lewis (1991) summarized chronic toxicity studies of nonionic surfactants and reported EC<sub>50</sub> values for a variety of fresh- and saltwater invertebrate species ranging

from 170-2500 µg/L. Fish toxicity values were less abundant and ranged from 50-50,000 µg/L. Without oxyfluorfen-surfactant toxicity studies, conclusions about the mixture effects cannot be drawn and the available surfactant toxicity data cannot be used to assess mixture toxicity. However, this information does provide evidence that pesticide adjuvants commonly used with oxyfluorfen may result in mixture effects.

### 9.3 *Temperature, pH, and other water quality effects*

Temperature, pH, and other water quality effects on the toxicity of oxyfluorfen were examined to determine if any effects are described well enough in the literature to incorporate into criteria compliance (section 3-5.3, TenBrook et al. 2009a). There were no studies available that examined the effects of temperature or pH on toxicity in the aqueous environment. As oxyfluorfen does not undergo dissociation in the environmentally relevant range, pH is not expected to have a significant effect on the chemical structure.

## 10 **Comparison of ecotoxicity data to derived criteria**

### 10.1 *Sensitive species*

The derived criteria are compared to toxicity values for the most sensitive species in both the acceptable (RR) and supplemental (RL, LR, LL) data sets to ensure that these species will be adequately protected (section 3-6.1, TenBrook et al. 2009a).

The lowest acute value in the data sets rated RR, RL, LR, or LL (Tables 3, 4, and 5) is 31.7 µg/L for the grass shrimp *Palamonetes pugio* (Vilkas 1977). This study rated LL because it was performed in saltwater and the chemical purity was low (74%). These parameters make this study less reliable for the purposes of the methodology, but it is still a relevant toxicity study. This study tested an aquatic species that resides in North America, the endpoint and exposure duration fit into the acute test definition in the methodology (section 3-2.1.1.1), and reported toxicity values with 95% confidence intervals. The next lowest acute value is 200 µg/L for a freshwater fish species (*Lepomis macrochirus*), which is rated RR. These values are well-above the derived chronic criterion of 0.14 µg/L and it is likely that if the chronic criterion were attained, sensitive aquatic animals would also be protected.

The derived chronic criterion (0.14 µg/L) is the lowest of all chronic data that was highly rated (Table 5) and is equal to the NOEC for growth inhibition of an aquatic plant. The next lowest acceptable value for another species is the larval mortality NOEC of 1.3 µg/L for the fathead minnow (Palmer et al. 2005). A supplemental plant study for *Navicula pelliculosa* reports a NOEC of 0.1 µg/L (Giddings 1990), which is the same order of magnitude as the derived criterion. This study used a low purity chemical and was therefore not acceptable; however, the similar value supports the magnitude of the derived criterion. Oxyfluorfen is an herbicide so it is expected that plants will be more

sensitive than animals, therefore the chronic criterion should be adequately protective of both plant and animal species.

## 10.2 *Ecosystem and other studies*

The derived criteria are compared to acceptable laboratory, field, or semi-field multispecies studies (rated R or L) to determine if the criteria will be protective of ecosystems (section 3-6.2, TenBrook et al. 2009a). There were no mesocosm, microcosm or ecosystem (field and laboratory) studies identified for oxyfluorfen.

## 10.3 *Threatened and endangered species*

The derived criteria are compared to measured toxicity values for threatened and endangered species (TES), as well as to predicted toxicity values for TES, to ensure that they will be protective of these species (section 3-6.3, TenBrook et al. 2009a). Current lists of state and federally listed threatened and endangered plant and animal species in California were obtained from the California Department of Fish and Game website (CDFG 2015). One listed animal species is represented in the dataset. Five Evolutionarily Significant Units of *Oncorhynchus mykiss* are listed as federally threatened or endangered throughout California. The acute data set include one 96-hr LC<sub>50</sub> value for *O. mykiss* of 250 (190-360) µg/L (Graves & Smith 1990b). While an acute criterion could not be calculated for oxyfluorfen (see section 7), the reference value for a non-conforming species in Table 3 is lower than the LC<sub>50</sub> value for *O. mykiss*, indicating that if the reference value were used, it would be protective of this species.

The USEPA interspecies correlation estimation (ICE v. 3.1; USEPA 2010) software was used to estimate toxicity values for the listed animals or plants represented in the acute data set by members of the same family or genus. Table 10 summarizes the results of the ICE analyses. The estimated toxicity values in Table 10 range from 354.53 µg/L for Chinook salmon, 357.33 µg/L for Coho salmon, 274.89 µg/L for cutthroat trout, and 192.39 µg/L for apache trout.

No plant studies used in the criteria derivation were of state or federal endangered, threatened or rare species. Plants are particularly sensitive to oxyfluorfen because it is an herbicide, but there are no aquatic plants listed as state or federal endangered, threatened or rare species so they could not be considered in this section.

Based on the available data and estimated values for animals, there is no evidence that the value referenced in place of a calculated acute and or the calculated chronic criteria will be underprotective of threatened and endangered species.

## 11 Harmonization with other environmental media

### 11.1 Bioaccumulation

Bioaccumulation was assessed to ensure that the derived criteria will not lead to unacceptable levels of oxyfluorfen in food items (section 3-7.1, TenBrook et al. 2009a). Oxyfluorfen has a log  $K_{ow}$  of 4.68 (BioByte 2015), a  $K_d$  of 10-850 depending on soil type (Anatra-Cordone et al. 2005), and a molecular weight of 361.7, which indicates a high bioaccumulative potential. There are no FDA action levels for oxyfluorfen in food (USFDA 2000), and there are no EPA pesticide tolerances set for any aquatic species (USEPA 1995). Bioconcentration of oxyfluorfen has been measured in unknown species (Table 1).

To check that these criteria are protective of terrestrial wildlife that may consume aquatic organisms, a bioaccumulation factor (BAF) was used to estimate the water concentration that would roughly equate to a reported toxicity value for such terrestrial wildlife ( $LC_{50, \text{oral predator}}$ ). These calculations are further described in section 3-7.1 of the methodology (TenBrook et al. 2009a). The BAF of a given chemical is the product of the BCF and a biomagnification factor (BMF), such that  $BAF = BCF \cdot BMF$ . No BMF value was found for oxyfluorfen. Chronic dietary toxicity values are preferred for this calculation. The BAF and BCF values available were either from an estimation modeling program (USEPA 2015a) or the value origin was not reported (PPDB 2015). A single dietary NOEC of 500 mg/kg feed for mallard (Frey et al. 2003) was the only dietary toxicity value available. The dietary NOEC of 500 mg/kg feed for mallard (Frey et al. 2003) and the BCF of 613.6 L/kg (USEPA 2015a) were used as an example estimation of bioaccumulation in the environment. No BMF value was available in the literature so it was estimated two ways according to the methodology (a value of 2 as approximated from log  $K_{ow}$  and a value of 1 as approximated from BCF as in section 3-7.1 and Table 3.15 in TenBrook et al. 2009a).

$$NOEC_{\text{water}} = \frac{NOEC_{\text{oral-predator}}}{BCF_{\text{food-item}} \cdot BMF_{\text{food-item}}}$$

Mallard:

$$NOEC_{\text{water, geomean}} = \frac{500 \text{ mg/kg}}{613.6 \text{ L/kg} * 1.4} = 0.58 \text{ mg/L} = 580 \text{ } \mu\text{g/L}$$

$$NOEC_{\text{water, 1}} = 0.41 \text{ mg/L}$$

$$NOEC_{\text{water, 2}} = 0.81 \text{ mg/L}$$

$$\text{Geomean } NOEC_{\text{water}} = 0.58 \text{ mg/L}$$



In this example, the calculated chronic criterion (0.14 µg/L) is more than two orders of magnitude below the estimated NOEC<sub>water</sub> value for wildlife and is not expected to cause adverse effects due to bioaccumulation.

## **11.2 Harmonization with air and sediment criteria**

This section addresses how the maximum allowable concentration of oxyfluorfen might impact life in other environmental compartments through partitioning (section 3-7.2, TenBrook et al. 2009a). One sediment study was available that used an acceptable oxyfluorfen concentration with a NOEC value of 312 µg/g organic carbon (OC) (Ding et al. 2011). The other available sediment criterion for oxyfluorfen is estimated based on partitioning from water using empirical K<sub>oc</sub> values. These range from 2,891 µg/L (sand) to 32,381 µg/L (silty clay loam) with 100,000 as the recommended value (Anatra-Cordone et al. 2005). There are no other federal or state sediment or air quality standards for oxyfluorfen (CARB 2008; CDWR 1995), nor is oxyfluorfen mentioned in the NOAA sediment quality guidelines (NOAA 1999). For biota, the limited data on bioconcentration or biomagnification of oxyfluorfen is addressed in section 11.1.

## **12 Oxyfluorfen Criteria Summary**

### **12.1 Limitations, assumptions, and uncertainties**

The assumptions, limitations and uncertainties involved in criteria generation are available to inform environmental managers of the accuracy and confidence in criteria (section 3-8.0, TenBrook et al. 2009a). Chapter 2 of the methodology (TenBrook et al. 2009a) discusses these points for each section as different procedures were chosen, such as the list of assumptions associated with using an SSD (section 2-3.1.5.1), and reviews them in section 2-7.0. This section summarizes any data limitations that affected the procedure used to determine the final oxyfluorfen criteria.

Overall, there was a lack of highly rated aquatic plant and animal toxicity data for oxyfluorfen. This was especially true for the acute data, which was lacking enough to prevent the use of either a SSD or an AF for criterion derivation. None of the required taxa were available for either method. Due to this lack of data, no acute criterion could be calculated. The only highly rated acute value available was a LC<sub>50</sub> of 200 µg/L for *L. machrochirus* (Bentley 1973). The lowest value available was for a grass shrimp, at about ten times lower than all other animal toxicity values (LC<sub>50</sub> of 31.7 µg/L). This is an important data gap, as this taxon appears to be the most sensitive animal taxa to oxyfluorfen. Additional aquatic animal toxicity studies for oxyfluorfen are needed in order to calculate an acute criterion.

The most important limitation is the lack of acceptable plant data because oxyfluorfen is an herbicide. Plant and algal data are difficult to interpret and do not use consistent endpoints. The assumptions that went into evaluation of plant studies are described in section 5. The chronic data set only contained three plant values, precluding

the use of a SSD, although all of the studies reported a NOEC, LOEC, and MATC, which are the appropriate toxicity values for chronic tests. The studies also reported EC<sub>50</sub> values. The methodology requires that MATC values are used to derive chronic criterion by the SSD procedure, unless studies are available with EC<sub>x</sub> values that show what level of *x* is appropriate to represent a no-effect level (section 3-2.1.1.2, TenBrook et al. 2009a). The chronic criterion was derived with the absolute minimum amount of data according to the methodology (part 2, section 3-4.3, TenBrook et al. 2009a) as the lowest NOEC from an important alga or vascular aquatic plant, and uncertainty in the chronic criterion cannot be quantified because it is based on only one toxicity value.

Chronic animal taxa requirements were not met, as only one value was available. However, chronic animal data is not used for chronic criterion derivation of an herbicide when plants are the most sensitive taxa to a particular pesticide (3-4.3, TenBrook et al. 2009a). Although oxyfluorfen is an herbicide, some animals do show sensitivity to it.

Other limitations include the lack of information about oxyfluorfen and mixture toxicity and ecosystem-level effects. Oxyfluorfen is often mixed with nonionic surfactant to increase its efficacy. No studies were found that tested the mixture effects of oxyfluorfen and surfactants but there is evidence from surfactant-only studies that some aquatic animals have sensitivity. Aquatic plant toxicity to nonionic surfactants were not available.

## 12.2 *Comparison to national standard methods*

This section is provided as a comparison between the UC-Davis methodology for criteria calculation (TenBrook et al. 2009a) and the current USEPA (1985) national standard. The following example oxyfluorfen criteria were generated using the USEPA (1985) methodology with the data set generated in this oxyfluorfen criteria report.

The USEPA acute methods have three additional taxa requirements beyond the five required by the SSD procedure of the UC-Davis methodology (section 3-3.1, TenBrook et al. 2009a). They are:

1. A third family in the phylum Chordata (e.g., fish, amphibian);
2. A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca);
3. A family in any order of insect or any phylum not already represented.

Only the first of the three additional requirements could be met with *L. macrochirus* and it is the only one of the eight total taxa requirements available in the data set. No other acute values are available. Because of this lack of data, no acute criterion could be calculated according to the USEPA (1985) methodology.

According to the USEPA (1985) methodology, the chronic criterion is equal to the lowest of the Final Chronic Value, the Final Plant Value, and the Final Residue Value.

To calculate the Final Chronic Value, animal data is used and the same taxa requirements must be met as in the calculation of the acute criterion (section III B USEPA 1985). One of the eight taxa requirements is available in the RR chronic animal data set (Table 6). The missing taxa are as follows:

1. A family Salmonidae in the class Osteichthyes
2. A third family in the phylum Chordata (may be in the class Osteichthyes or may be an amphibian, etc.)
3. A planktonic crustacean (e.g., cladoceran, copepod, etc.)
4. A benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish, etc.)
5. An insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)
6. A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca, etc.)
7. A family in any order of insect or any phylum not already represented.

The California Department of Fish and Game has derived criteria using the USEPA (1985) SSD method with fewer than the eight required families, using professional judgment to determine that species in the missing categories were relatively insensitive and their addition would not lower the criteria (Menconi & Beckman 1996; Siepmann & Jones 1998). In this case, there are too many missing taxa values to derive a Final Chronic Value in this way.

The Final Plant Value is calculated as the lowest result from a 96-hr test conducted with an important plant species in which the concentrations of test material were measured and the endpoint was biologically important. None of the plant toxicity values in the RR data set (Table 5) are for a 96-hr test, although two are longer tests (120 hours and 14 days). The closest test that fits this description is the 120-hr NOEC of 0.14 µg/L reported for *Lemna gibba* (Roshon 2002b), which also serves as the derived chronic criterion.

Final Plant Value = lowest result from a plant test  
= 0.14 µg/L

The Final Residue Value is calculated by dividing the maximum permissible tissue concentration by an appropriate bioconcentration or bioaccumulation factor. A maximum allowable tissue concentration is either (a) a FDA action level for fish oil or for the edible portion of fish or shellfish, or (b) a maximum acceptable dietary intake based on observations on survival, growth, or reproduction in a chronic wildlife feeding study or long-term wildlife field study. There are no FDA action levels for oxyfluorfen in food (USFDA 2000) and there are no EPA pesticide tolerances set for any aquatic species (USEPA 1995). A single dietary NOEC of 500 mg/kg feed for mallard (Frey et al. 2003) was the only wildlife dietary toxicity value available. A BCF of 613.6 for an unknown species (Table 1) is used to calculate the Final Residue Value.

Final Residue Value = maximum acceptable dietary intake ÷ BCF

$$\begin{aligned}
&= 500 \text{ mg/kg} \div 613.6 \text{ L/kg} \\
&= 0.8149 \text{ mg/L} \\
&= 814.9 \text{ } \mu\text{g/L}
\end{aligned}$$

The Final Plant Value is lower than the Final Residue Value. A Final Chronic Value cannot be calculated. Therefore the chronic criterion by the USEPA (1985) methodology would be 0.14  $\mu\text{g/L}$ . The example chronic criterion is equivalent to the one recommended by the UC-Davis methodology.

### 12.3 *Final criteria statement*

The final criteria statement is:

Aquatic life in the Sacramento River and San Joaquin River basins should not be affected unacceptably if the four-day average concentration of oxyfluorfen does not exceed 0.14  $\mu\text{g/L}$  (140 ng/L) more than once every three years on the average.

An acute criterion could not be calculated with the data available at this time so a maximum one-hour average concentration that can occur once every three years on average cannot be stated. Although the criteria were derived to be protective of aquatic life in the Sacramento and San Joaquin Rivers, these criteria would be appropriate for any freshwater ecosystem in North America, unless species more sensitive than are represented by the species examined in the development of these criteria are likely to occur in those ecosystems.

An acute criterion should be based only on acute animal data to protect animals from acute pulses of oxyfluorfen. However, an acute criterion could not be calculated from the available data. For discussion and comparison purposes only, a reference value is given from a highly rated study in lieu of a derived criterion. Details of acute criterion calculation are described in section 7 and the acute data are shown in Tables 3 - 5.

Details of the chronic criterion calculation are described in section 8 and chronic plant data are shown in Tables 6a, 7 and 8a. The chronic criterion was derived to only be protective of plants, but will also likely be protective of animals, which are less sensitive to oxyfluorfen. The lowest NOEC of a highly rated plant study was used as the criterion because there were insufficient data for use of a SSD for criterion calculation. The chronic criterion was calculated with the absolute minimum amount of data, and uncertainty cannot be quantified. One plant toxicity value in the supplemental data set is lower than the derived chronic criterion (*Navicula pelliculosa*), but the study was not appropriate for criteria derivation or adjustment; this study is discussed in detail in section 12. Thus, it is not currently recommended that the criteria be adjusted downward based on this data. Plant toxicity data is essential when considering oxyfluorfen usage and regulations because plants and algae are the most sensitive taxa. The chronic criterion was derived using the best data available, and firm evidence that could support lowering criteria was not found. The criteria should be updated whenever new relevant and reliable data is available.

There are no established water quality criteria for oxyfluorfen with which to compare the criteria derived in this report. The US EPA has several aquatic life benchmarks established for oxyfluorfen, shown in Table 11, to which the derived criteria in this report can be compared with caution (USEPA 2015b). According to the USEPA (2015b), aquatic life benchmarks are not calculated following the same methodology used to calculate water quality criteria. Water quality criteria can be used to set water quality standards under the Clean Water Act, but aquatic life benchmarks may not be used for this purpose (USEPA 2015b).

The referenced acute toxicity value of 200 µg/L is above the acute fish benchmark of 101.5 µg/L by about a factor of 2, and about a factor of 5 above the acute invertebrate benchmark of 40 µg/L. The derived chronic criterion of this report is below the chronic benchmarks for fish and invertebrates (1.3 µg/L and 13 µg/L, respectively), as well as the acute nonvascular plant benchmark of 0.29 µg/L. Because the chronic criterion was derived using only plant data, it is most comparable to the acute nonvascular plant benchmark. The Environmental Risk Assessment for the Reregistration of Oxyfluorfen (USEPA 2002) does not include data for aquatic plants because no data was available at the time of publication. Indeed, the three highly rated aquatic plant toxicity studies available for this report were published in the same year as the Reregistration assessment and were likely not yet available for inclusion. The use of the NOEC value as the chronic criterion is recommended by the UC-Davis method and the USEPA (1985) method, in order to be protective of nonvascular plants. The only aquatic plant study available in the Reregistration assessment is for a very low chemical purity (23.2%), resulting in an EC<sub>50</sub> of 0.29 µg/L, which is a factor of 2 higher than the derived chronic criterion.

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## **Data Tables**

Table 3 Final acute toxicity data set for oxyfluorfen.

All studies were rated RR and were conducted at standard temperature. S: static; SR: static renewal; FT: flow-through.

Species	Common Identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	LC/EC <sub>50</sub> (µg/L) (95% CI)	Reference
<i>Lepomis macrochirus</i>	Bluegill	Centrarchidae	FT	Nom	94.00%	96-h	21	Mortality	1.0 g, 42 mm	200 (130-310)	Bentley 1973

Table 4 Supplemental acute data rated RL, LR, LL.

Reason for exclusion given below. S: static; SR: static renewal; FT: flow-through. NR: not reported. 95% CI: 95% confidence interval. Exclusion reasons are listed at the end of the table.

Species	Common Identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	LC/EC <sub>50</sub> (µg/L) (95% CI)	Reference	Rating/ Reason
<i>Ictalurus punctatus</i>	Channel catfish	Ictaluridae	S	Nom	74.00%	96-h	22	Mortality	3-m	400 (360-450)	Kuc 1977	LL 2, 3
<i>Leopmis macrochirus</i>	Bluegill	Centrarchideae	FT/S	Meas	71.40%	96-h	22	Mortality	Juveniles	210 (180-350)	Graves & Smith 1991a	LR 2
<i>Oncorhynchus mykiss</i>	Rainbow trout	Salmonidae	S	Meas	71.40%	96-h	12	Mortality	Juveniles	250 (190-360)	Graves & Smith 1991b	LR 2
<i>Palaemonetes pugio</i>	Grass shrimp	Palaemonidae	S	Nom	74.00%	96-h	18	Mortality	2.75 cm, 0.33 g	31.7 (26.1-38.4)	Vilkas 1977	LL 1, 2

#### Exclusion Reasons

1. Saltwater
2. Low chemical purity or purity not reported
3. Low reliability score

Table 5 Final chronic plant toxicity data set for oxyfluorfen.

All studies were rated RR. S: static; SR: static renewal; FT: flow-through. NR: not reported, n/a: not applicable.

Species	Common identifier, Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	72-h	24	Growth inhibition (Cell count), Growth rate	3-7-d	69.2	101.25	83.7	Roshon 2002a
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	7-d	25	Growth inhibition (Live colony number)	7-10-d	0.14	0.54	0.27	Roshon 2002b
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	120-h	24	Growth inhibition (Cell number), Growth rate, Area under curve	5-d	18.3	40.4	27.19	Roshon 2002c

Table 6 Final chronic animal toxicity data set for oxyfluorfen.

All studies were rated RR. S: static; SR: static renewal; FT: flow-through. NR: not reported

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference
<i>Pimephales promelas</i>	Fathead minnow	FT	Meas	99.30%	33-d	25	Hatching success, Mortality (larval)	5-d	1.3	2.4	1.8	Palmer et al. 2005

Table 7 Acceptable reduced chronic data rated RR.

Reason for exclusion given below. S: static; SR: static renewal; FT: flow-through. NC: not calculable; NR: not reported; LOQ: limit of quantification.

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference	Reason for exclusion
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	24-h	24	Growth inhibition (Cell count )	3-7-d	101.25	>101.25	NC	Roshon 2002a	B, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	48-h	24	Growth inhibition (Cell count )	3-7-d	101.25	>101.25	NC	Roshon 2002a	B, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	96-h	24	Growth inhibition (Cell count )	3-7-d	101.25	>101.25	NC	Roshon 2002a	C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	120-h	24	Growth inhibition (Cell count )	3-7-d	101.25	>101.25	NC	Roshon 2002a	C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	24-h	24	Area under growth curve	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	48-h	24	Area under growth curve	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	72-h	24	Area under growth curve	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	96-h	24	Area under growth curve	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	120-h	24	Area under growth curve	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	24-h	24	Growth rate	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	48-h	24	Growth rate	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	96-h	24	Growth rate	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C



Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference	Reason for exclusion
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	99.30%	120-h	24	Growth rate	3-7-d	101.25	>101.25	NC	Roshon 2002a	A, C
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	7-d	25	Growth inhibition (Live frond number)	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	14-d	25	Growth inhibition (Live frond number)	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	7-d	25	Growth inhibition (Live colony number)	7-10-d	0.14	0.54	0.27	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	7-d	25	Area under growth curve	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	14-d	25	Area under growth curve	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	7-d	25	Growth rate	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	14-d	25	Growth rate	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Lemna gibba</i>	Aquatic plant	SR	Meas	99.30%	14-d	25	Growth inhibition (Dry weight)	7-10-d	<LOQ	0.14	NC	Roshon 2002b	A
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	24-h	24	Growth inhibition (Cell number)	5-d	130.4	>130.4	NC	Roshon 2002c	B, C
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	48-h	24	Growth inhibition (Cell number)	5-d	130.4	>130.4	NC	Roshon 2002c	B, C
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	72-h	24	Growth inhibition (Cell number)	5-d	18.3	40.4	27.19	Roshon 2002c	B

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference	Reason for exclusion
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	96-h	24	Growth inhibition (Cell number)	5-d	18.3	40.4	27.19	Roshon 2002c	B
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	24-h	24	Area under growth curve	5-d	130.4	>130.4	NC	Roshon 2002c	B, C
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	72-h	24	Area under growth curve	5-d	18.3	40.4	27.19	Roshon 2002c	B
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	96-h	24	Area under growth curve	5-d	18.3	40.4	27.19	Roshon 2002c	B
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	24-h	24	Growth rate	5-d	130.4	>130.4	NC	Roshon 2002c	B, C
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	48-h	24	Growth rate	5-d	122.45	130.4	126.36	Roshon 2002c	B
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	72-h	24	Growth rate	5-d	18.3	40.4	27.19	Roshon 2002c	B
<i>Navicula pelliculosa</i>	Diatom	S	Meas	99.30%	96-h	24	Growth rate	5-d	18.3	40.4	27.19	Roshon 2002c	B
<i>Pimephales promelas</i>	Fathead minnow	FT	Meas	99.30%	33-d	25	Legnth	5-d	1.3	NC	NC	Palmer et al 2005	A
<i>Pimephales promelas</i>	Fathead minnow	FT	Meas	99.30%	33-d	25	Wet weight	5-d	1.3	NC	NC	Palmer et al 2005	A
<i>Pimephales promelas</i>	Fathead minnow	FT	Meas	99.30%	33-d	25	Dry weight	5-d	1.3	NC	NC	Palmer et al 2005	A

A. Less sensitive endpoint

B. Later test duration available

C. MATC not calculable

Table 8 Supplemental chronic plant data rated RL, LR, or LL.

S: static; SR: static renewal; FT: flow-through. NR: not reported, n/a: not applicable; 95% CI: 95% confidence interval; SE: standard error.

Species	Common identifier	Test type	Meas / Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (µg/L)	LOEC (µg/L)	EC <sub>50</sub> (µg/L) (95% CI)	Reference	Rating/ Reason for exclusion
<i>Anabena flos-aquae</i>	Cyanobacterium	S	Meas	71.50%	5-d	25	Growth inhibition (Cell count)	3-d	2000	NR	>2000	Giddings 1990	LR 1
<i>Lemna gibba</i>	Duckweed, Araceae	S	Meas	71.50%	14-d	21	Growth inhibition (FronD growth)	8-d	<0.55	NR	1.4 (.87-2.4)	Giddings 1990	LR 1
<i>Navicula pelliculosa</i>	Diatom	S	Meas	71.50%	5-d	25	Growth inhibition (Biomass)	2-d	0.1	NR	0.24 (0.066-0.82)	Giddings 1990	LR 1
<i>Raphidoelis subcapitata</i>	Microalga	S	Meas	71.50%	5-d	25	Growth inhibition (Biomass)	Algal cells	0.32	NR	0.35 (0.33-0.37)	Giddings 1990	LR 1
<i>Skeletonema costatum</i>	Diatom	S	Meas	71.50%	5-d	21	Growth inhibition (Biomass)	5-d	2.5	NR	3.3 (1.1-5.8)	Giddings 1990	LR 1

#### Exclusion Reasons

1. Low chemical purity or purity not reported

Table 9 Supplemental chronic animal data rated RL, LR, or LL.

S: static; SR: static renewal; FT: flow-through. NR: not reported.

Species	Common identifier	Test type	Meas /Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (mg/L)	LOEC (mg/L)	MATC (mg/L)	Reference	Rating/ Reason for exclusion
<i>Americamysis bahia</i>	saltwater mysid	FT	Meas	99.30%	15-d	25	Mortality	<24-h	16	NR	NR	Blankenship et al. 2005	LR 1
<i>Americamysis bahia</i>	saltwater mysid	FT	Meas	99.30%	30-d	25	Mortality	<24-h	16	NR	NR	Blankenship et al. 2005	LR 1
<i>Americamysis bahia</i>	saltwater mysid	FT	Meas	99.30%	30-d	25	Reproduction	<24-h	8.6	16	12	Blankenship et al. 2005	LR 1
<i>Americamysis bahia</i>	saltwater mysid	FT	Meas	99.30%	30-d	25	Growth	<24-h	16	25	20	Blankenship et al. 2005	LR 1
<i>Americamysis bahia</i>	saltwater mysid	FT	Meas	99.30%	30-d	25	Mortality	<24-h	8.6	16	12	Blankenship et al. 2005	LR 1
<i>Americamysis bahia</i>	saltwater mysid	FT	Meas	99.30%	30-d	25	Growth	<24-h	16	25	20	Blankenship et al. 2005	LR 1
<i>Daphnia magna</i>	Daphnid	FT	Meas	71.80%	21-d	20	Length	<24-h	13	28	19	Godfrey & Longacre 1990a	LR 2
<i>Daphnia magna</i>	Daphnid	FT	Meas	71.80%	21-d	20	Mortality	<24-h	13	28	19	Godfrey & Longacre 1990a	LR 2
<i>Daphnia magna</i>	Daphnid	FT	Meas	71.80%	21-d	20	Number of young/adult	<24-h	13	28	19	Godfrey & Longacre 1990a	LR 2

Species	Common identifier	Test type	Meas /Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (mg/L)	LOEC (mg/L)	MATC (mg/L)	Reference	Rating/ Reason for exclusion
<i>Pimephales promelas</i>	Fathead minnow	FT	Meas	71.00%	30-d	25	Mortality	<24-h	38	74	53	Godfrey & Longacre 1990b	LR 2

#### Exclusion Reasons

1. Saltwater
2. Low chemical purity or purity not reported

Table 10 Threatened, Endangered, or Rare Species Predicted values by ICE.

Surrogate		Predicted	
Species	LC <sub>50</sub> (µg/L)	Species	LC <sub>50</sub> (95% confidence interval) (µg/L)
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	250	Chinook salmon ( <i>O. tshawytscha</i> )	354.53 (213.20-589.55)
		Coho salmon ( <i>O. kisutch</i> )	357.33 (297.86-428.68)
		Cutthroat trout ( <i>O. clarkii</i> )	274.89 (218.74-345.45)
		Apache trout ( <i>O. gilae</i> )	192.39 (139.03-266.22)

Table 11 US EPA Aquatic Life Benchmarks.				
All units are µg/L. (USEPA 2015b)				
Acute Fish	Chronic Fish	Acute Invertebrates	Chronic Invertebrates	Acute nonvascular plants
101.5	1.3	40	13	0.29

## **Appendix A – Aqueous Toxicity Data Summaries**



## **Appendix A1 – Aqueous Toxicity Studies Rated RR**

## Water Toxicity Data Summary

### *Anabena flos-aquae*

Study: Roshon, R. 2002a. Oxyfluorfen (Goal): Growth inhibition test with the freshwater bluegreen alga, *Anabena flos-aquae*. ESG International, Inc., Guelph, Canada. ESG study ID # S2310-01. Submitted to Down AgroSciences, LLC, Indianapolis, Indiana. Dow study ID # 021019. EPA MRID 45861104.

#### Relevance

Score: 100

Rating: R

#### Reliability

Score: 93

Rating: R

Relevance points taken off for: none

	<b>Roshon 2002a</b>	<b><i>A. flos-aquae</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	FIFRA, 1982. Pesticide Assessment Guidelines, subdivision J. Hazard Evaluation: Non-target Plants. By R.W. Holst and T.C. Ellwanger. Office of Pesticide Programs. Washington, DC.  USEPA, 1996. Algal Toxicity, Tiers I and II. OPPTS 850.5400. EPA Ecological Effects Test Guidelines.	
Phylum/subphylum	Cyanobacteria	
Order	Nostocales	
Family	Nostocaceae	
Genus	<i>Anabena</i>	
Species	<i>Flos-aquae</i> (Lyng.) Breb.	
Family native to North America?	Yes	
Age/size at start of test/growth phase	3-7 d, 1 x 10 <sup>4</sup> cells/mL	
Source of organisms	University of Toronto Culture Collection (UTCC# 67)	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Not reported	

	<b>Roshon 2002a</b>	<i>A. flos-aquae</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test vessels randomized?	Not reported	
Test duration	120 h	
Data for multiple times?	Yes	24, 48, 72, 96, 120h
Effect 1:	Cell number	
Control response 1, mean x 10, 000 (nutrient; solvent)	24 h: 5.45 (1.93), 8.38 (6.09) 48 h: 10.23 (4.15), 15.29 (7.90) 72 h: 15.14 (6.38), 14.74 (2.67) 96 h: 26.45 (6.58), 29.13 (7.24) 120 h: 91.19 (31.40), 101.78 (7.25)	
Effect 2:	Area under growth curve	
Control response 2, mean x 10, 000 (stdev) (negative; solvent)	0-24 h: 39.88 (24.10), 76.44 (76.16) 24-48 h: 132.47 (65.78), 227.32 (149.54) 48-72 h: 252.72 (124.90), 309.25 (121.44) 72-96 h: 407.74 (137.33), 432.77 (89.63) 96-120 h: 139983 (466.80), 1563.95 (66.88) 0-72 h: 425.06 (200.98), 613.00 (321.56) 0-96 h: 832.8 (320.71), 1045.77 (402.89) 0-120 h: 2232.63 (771.05), 2609.72 (456.13)	
Effect 3:	Growth rate	
Control response 3, mean x 10, 000 (negative; solvent)	0-24 h: 0.03284 (0.01686), 0.04505 (0.2762) 0-48 h: 0.2961 (0.00872), 0.03693 (0.01137) 0-72 h: 0.02511 (0.00592), 0.2552 (0.00244) 0-96 h: 0.02563 (0.00281), 0.02664 (0.00283) 0-120 h: 0.03048 (0.00301), 0.03178 (0.00058)	
Temperature	24 ± 2 °C	
Test type	Static	

	<b>Roshon 2002a</b>	<i>A. flos-aquae</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Photoperiod/light intensity	Continuous, 2000 ± 15% lux	
Dilution water	Freshwater medium (ASTM, 1997) without EDTA	
pH	7.5 ± 0.1	
Feeding	Freshwater medium & nutrient solution	ASTM 1997. Standard guide for conducting static 96-h toxicity tests with microalgae. Annual Book of ASTM Standards. American Society for Testing and Materials. West Conshohocken, PA. Vol. 11.05.E1218-97a.
Purity of test substance	99.3%	
Concentrations measured?	Yes	
Measured is what % of nominal?	40-75%	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC-ECD	
Concentration of carrier (if any) in test solutions		
Concentration 1 Nom; Meas (µg/L)	7.81; 5.8	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Concentration 2 Nom; Meas (µg/L)	15.63, 11.20	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Concentration 3 Nom; Meas (µg/L)	31.25, 20.05	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Concentration 4 Nom; Meas (µg/L)	62.50, 47.15	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Concentration 5 Nom; Meas (µg/L)	125.00, 69.20	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Concentration 6 Nom; Meas (µg/L)	250.00, 101.25	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Control 1 Nom; Meas (µg/L)	Nutrient, 0.0	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep
Control 2 Nom; Meas (µg/L)	Solvent, 0.0	4 reps, 2 x 10 <sup>4</sup> cells/mL/rep

	<b>Roshon 2002a</b>	<i>A. flos-aquae</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
EC <sub>50</sub> (95% CI) (µg/L)	Effects 1 & 3: >101.25, all times Effect 2: 101.06 (39.5-101.09), 0-24 h Effect 2: >101.25, all other times Effect 3: >101.25, all other times	Method: ANOVA w/ TOXSTAT program
NOEC	Effect 1: 69.20, 72 h Effect 1: 101.25, 24, 48, 96, 120 h Effect 2: 101.25, all times Effect 3: 69.20, 0-72 h Effect 3: 101.25, 0-all other times	Method: ANOVA w/ TOXSTAT program p: not reported MSD: not reported
LOEC	Effect 1: 101.25, 72 h Effect 3: 101.25, 0-72 h All other effects, times: >101.25	
MATC (GeoMean NOEC, LOEC)	Effect 1: 83.7, 72 h Effect 3: 83.7, 0-72 h All others: not calculable	
Effect 1: % control at NOEC	24 h: 65.8% 48 h: 68.1% 72 h: 81.9% 96 h: 87.6% 120 h: 78.9%	24 h (NOEC = 101.25) cell count: 4.56 (tmt) / mean of 5.45, 8.38 (controls) = 65.8% 48 h: 8.7 (tmt) / mean of 10.23, 15.29 = 68.1% 72 h (NOEC = 69.2) cell count: 12.25 (tmt) / mean of 15.14, 14.74 (controls) = 54.4% 96 h (NOEC = 101.25) cell count: 24.35 (tmt) / mean of 26.45, 29.13 (controls) = 87.6% 120 h: 76.13 (tmt) / mean of 91.19, 101.78 (controls) = 78.9%

	<b>Roshon 2002a</b>	<b><i>A. flos-aquae</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1: % control at LOEC	72 h: 54.4% All other times: not calculable	72 h: 8.13 (tmt) / mean of 15.14, 14.74 (controls) = %
Effect 2: % control at NOEC	0-24 h: 49.5% 24-48 h: 57.7% 48-72 h: 53.1% 72-96 h: 73.1% 96-120h: 80.1% 0-72 h: 113.5% 0-96 h: 80.1% 0-120 h: 73.4%	0-24 h (NOEC = 101.25) area: 28.78 (tmt) / mean of 39.88, 76.44 (controls) = 49.5% 24-48 h: area: 103.82 (tmt) / mean of 132.47, 227.32 (controls) = 57.7 % 48-72 h: area: 149.20 (tmt) / mean of 252.72, 309.25 (controls) = 53.1% 72-96 h: area: 307.51 (tmt) / mean of 407.74, 432.77 (controls) = 73.1 % 96-120h: area: 1187.44 (tmt) / mean of 1399.83, 1563.95 (controls) = 80.1% 0-72 h: area: 281.8(tmt) / mean of 425.06, 613.00 (controls) = % 0-96 h: area: 589.30 (tmt) / mean of 832.80, 1045.77 (controls) = 113.5% 0-120 h: area: 1776.58 (tmt) / mean of 2232.63, 2609.72 (controls) = 73.4 %

	<b>Roshon 2002a</b>	<b><i>A. flos-aquae</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 2: % control at LOEC	Not calculable	
Effect 3: % control at NOEC	0-24 h: 47.7% 0-48 h: 73.3% 0-72 h: 88.6% 0-96h: 98.1% 0-120 h: 95.7%	0-24 h (NOEC = 101.25) rate: 0.01857 (tmt) / mean of 0.03284, 0.04505 (controls) = 47.7% 0-48 h: rate: 0.02440 (tmt) / mean of 0.02961, 0.03693 (controls) = 73.3% 0-72 h: rate: 0.02244 (tmt) / mean of 0.02511, 0.02552 (controls) = 88.6% 0-96 h: rate: 0.02587 (tmt) / mean of 0.02563, 0.02664 (controls) = 98.1% 0-120h: rate: 0.02979 (tmt) / mean of 0.03048, 0.03178 (controls) = 95.7%
Effect 3: % control at LOEC	0-72 h: 64.4% All other times: not calculable	0-72h: rate: 0.01631 (tmt) / mean of 0.02511, 0.02552 (controls) = 64.4 %

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Statistical significance (2), Significance level (2), Minimum significant difference (2). Total: 100 – 6 = 94

Acceptability: Measured concentrations within 20% nominal (4), Organisms randomized (1), Random design (2), Minimum significant difference (1). Total: 100 - 8 = 92

**Reliability score: mean (94, 92) = 93**

## Water Toxicity Data Summary

### *Lemna gibba*

Study: Roshon, R. 2002b. Oxyfluorfen (Goal) growth inhibition test with the freshwater aquatic plant, *Lemna gibba* L. G3. ESG International, Inc., Guelph, Canada. ESG study ID # S2310-04. Submitted to Dow AgroSciences, LLC, Indianapolis, Indiana. Dow study ID # 021022 EPA MRID 45861103.

#### Relevance

Score: 100

Rating: R

#### Reliability

Score: 95

Rating: R

Relevance points taken off for: none

	<b>Roshon 2002b</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Federal Insecticide, Fungicide, and Rodenticide Act, 1982, Pesticide Assessment Guidelines, Subdivision 1.  EPA, 1996, Ecological Effects Test Guidelines, OPPTS 850.04400, Aquatic Plant Toxicity Test using <i>Lemna</i> spp. Tiers I and II, EPA 712-C-96-156.	
Order	Alismatales	
Family	Araceae	
Genus	<i>Lemna</i>	
Species	<i>gibba</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	7-10 d	
Source of organisms	ESG International Toxicity Laboratory, Guelph, Ontario, Canada	Axenic culture
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	≥ 3 weeks
Animals randomized?	Not reported	
Test vessels randomized?	Not reported	
Test duration	14 d	
Data for multiple times?	Yes	0, 3, 7, 10, 14 d
Effect 1:	Live frond number	



	<b>Roshon 2002b</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Control response 1, mean (nutrient; solvent)	0 d: 12 (0.0), 12 (0.0) 3 d: 38.8 (2.1), 36.5 (2.6) 7 d: 175.5 (8.7), 161.3 (7.8) 10 d: 409.3 (23.3), 306.3 (25.3) 14 d: 826.3 (15.6), 778.3 (30.2)	
Effect 2:	Live colony number	
Control response 2, mean (nutrient; solvent)	0 d: 3 (0.0), 3 (0.0) 3 d: 6.0 (0.8), 6.0 (0.8) 7 d: 34.8 (5.0), 36.3 (1.7) 10 d: 1.05.5 (7.2), 97.5 (7.5) 14 d: 206.8 (8.1), 190.8 (9.8)	
Effect 3:	Area under growth curve	
Control response 3, mean (nutrient; solvent)	7 d: 10051.16 (573.43), 9181.91 (567.42) 14 d: 86771.94 (3241.06), 79585.78 (2715.13)	
Effect 4:	Growth rate	
Control response 4, mean (nutrient; solvent)	0-7 d: 0.01613 (0.00030), 0.01562 (0.00030) 0-14 d: 0.01274 (0.00006), 0.01256 (0.00012)	
Effect 5:	Dry weight	
Control response 5, mean (nutrient; solvent)	0 d: 1.64 (0.08), pooled 14 d: 87.49 (14.82), 79.58 (2.90)	
Temperature	25 ± 2 °C	
Test type	Static renewal	Solution renewal 3, 7, 10 d
Photoperiod/light intensity	Continuous, > 6000 lux	Cool-white fluorescent
Dilution water	20X-AAP medium	ASTM, 1998; OECD, 2000
pH	7.5 ± 0.1	Growth medium
Feeding	Growth medium, 20X-AAP medium	
Purity of test substance	99.3%	
Concentrations measured?	Yes	
Measured is what % of nominal?	73-97	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC-ECD	
Concentration of carrier (if any) in	0.5 mL/L acetone	

	<b>Roshon 2002b</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
test solutions		
Concentration 1 Nom; Meas (µg/L)	0.02; 0.2	4 reps, 12 fronds/rep
Concentration 2 Nom; Meas (µg/L)	0.06; 0.06	4 reps, 12 fronds/rep
Concentration 3 Nom; Meas (µg/L)	0.19; 0.14	4 reps, 12 fronds/rep
Concentration 4 Nom; Meas (µg/L)	0.56; 0.50	4 reps, 12 fronds/rep
Concentration 5 Nom; Meas (µg/L)	1.67; 1.71	4 reps, 12 fronds/rep
Concentration 6 Nom; Meas (µg/L)	5.00; 5.86	4 reps, 12 fronds/rep
Control 1 Nom; Meas (µg/L)	Nutrient, 0; 0	4 reps, 12 fronds/rep
Control 2 Nom; Meas (µg/L)	Solvent, 0;0	4 reps, 12 fronds/rep
EC <sub>50</sub> (95% CI) (µg/L)	Effect 1: 0.46 (0.40-0.52), 7d Effect 2: 0.65 (0.45-0.96), 7d Effect 4: 1.57 (1.33-1.77), 0-7d Effect 1: 0.32 (0.27-0.38), 14 d Effect 2: 0.32 (0.27-0.37), 14d Effect 3: 0.51 (0.41-0.61), 7d; 0.34 (0.31, 0.38), 14 d Effect 4: 0.95 (0.86-1.07), 0-14d Effect 5: 0.40 (0.34-0.50), 14d	Method: Norberg-King (1993)
NOEC	Effects 1, 3-5 < LOQ Effect 2: 0.14 µg/L (7d), <LOQ (14 d)	Method: ANOVA p: not reported MSD: n/a
LOEC	Effects 1, 3-5: 0.14 (7 & 14d) Effect 2: 0.54 (7 d), 0.14 (14 d)	
MATC (GeoMean NOEC, LOEC)	Effects 1, 3-5: not calculable Effect 2: 0.27 (7 d)	
Effect 1: % control at NOEC	Effects 1, 3-4: not calculable	

	<b>Roshon 2002b</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1: % control at LOEC	7 d: 85.7 14 d: 76.1	7 d (LOEC = 0.14) frond count: 144.3 (tmt) / mean of 175.3, 161.3 (controls) = 85.7% 14 d (LOEC = 0.14) frond count: 610.5 (tmt) / mean of 826.3, 778.3 (controls) = 76.1 %
Effect 2: % control at NOEC	7 d: 83.0	7 d (LOEC = 0.14) colony count: 29.5 (tmt) / mean of 34.8, 36.3 (controls) = 83.0 %
Effect 2: % control at LOEC	7 d: 53.4 14 d: 75.9	7 d (LOEC = 0.54) colony count: 19.0 (tmt) / mean of 34.8, 36.3 (controls) = 53.4 % 14 d (LOEC = 0.14) colony count: 150.8 (tmt) / mean of 206.8, 190.8 (controls) = 75.9 %
Effect 3: % control at NOEC	Not calculable	
Effect 3: % control at LOEC	7 d: 89.6 14 d: 77.7	7 d (LOEC = 0.14) area: 8617.41(tmt) / mean of 10051.16, 9181.91 (controls) = 89.6 % 14 d (LOEC = 0.14) area: 64622.5 (tmt) / mean of 86771.94, 79585.78 (controls) = 77.7 %
Effect 4: % control at NOEC	Not calculable	
Effect 4: % control at LOEC	0-7 d: 94.2 0-14 d: 93.5	0-7 d (LOEC = 0.14) rate: 0.01495(tmt) / mean of 0.01613, 0.01562 (controls) = 94.2 % 0-14 d (LOEC = 0.14) rate: 0.1183 (tmt) / mean of 0.1274, 0.1256

	<b>Roshon 2002b</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
		(controls) = 93.5 %
Effect 5: % control at NOEC	Not calculable	
Effect 5: % control at LOEC	0 d: not calculable 14 d: 86.7	14 d (LOEC = 0.14) dry weight: 72.42 (tmt) / mean of 87.49, 79.58 (controls) = 86.7 %

Notes: ASTM and EPA methodologies for plants indicate 7 d exposure while this study went for 14 d total.

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points were not taken off for water quality parameters (hardness, alkalinity, conductivity) because there is no guidance for these parameters in the test guidelines for algal/plant studies, the growth medium used requires distilled water, and the medium is presumably appropriate for the test species because a specific culture media was used.

Reliability points taken off for:

Documentation: Statistical significance (2), Significance level (2), Minimum significant difference (2). Total: 100 - 6 = 94

Acceptability: Organisms randomized (1), Random design (2), Minimum significant difference (1). Total: 100 - 4 = 96

**Reliability score: mean (94, 96) = 95**

## Water Toxicity Data Summary

### *Lepomis macrochirus*

Study: Bentley, Robert E. 1973. Acute toxicity of RH-2915 to bluegill (*Lepomis macrochirus*) and rainbow trout (*Salmo gairdneri*). Bionomics, Inc., Wareham, MA. Submitted to Rohm & Haas Company, Bristol, PA. CDPR study ID 2975. USEPA study ID 38574

#### Relevance

Score: 100

Rating: R

#### Reliability

Score: 79

Rating: R

Relevance points taken off for: none.

	<b>Bentley 1973</b>	<b><i>L. macrochirus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Fish Bioassay Procedures. 1970. <i>Standard Methods</i> (APHA).	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Perciformes	
Family	Centrarchidae	
Genus	<i>Lepomis</i>	
Species	<i>macrochirus</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	Mean mass 1.0 g, mean length 42 mm	
Source of organisms	Commercial fish hatchery in Nebraska	
Have organisms been exposed to contaminants?	No	Commercial hatchery—assumed not
Animals acclimated and disease-free?	Yes, 48 h	7d acclimation required for hatchery arrivals
Animals randomized?	Not reported	
Test vessels randomized?	Not reported	
Test duration	96 h	
Data for multiple times?	Yes, 24 and 96 h	
Effect 1	Mortality	
Control response 1	100% survival	
Temperature	21± 1.0 °C	
Test type	Flow through	
Photoperiod/light intensity	Not reported	
Dilution water	Aerated well water	
pH	7.1	
Hardness	38 mg/L CaCO <sub>3</sub>	

	<b>Bentley 1973</b>	<b><i>L. macrochirus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Alkalinity	Not reported	
Conductivity	Not reported	
Dissolved Oxygen	8.6-9.5 mg/L >60%	96.41 – 106.5 %
Feeding	Not reported	
Purity of test substance	94%	
Concentrations measured?	No	
Measured is what % of nominal?	Not applicable	
Toxicity values calculated based on nominal or measured concentrations?	Nominal	
Chemical method documented?	No	
Concentration of carrier (if any) in test solutions	None	
Concentration 1 Nom; Meas (µg/L)	56; Not reported	1 reps, 30/rep
Concentration 2 Nom; Meas (µg/L)	75; Not reported	1 reps, 30/rep
Concentration 3 Nom; Meas (µg/L)	100; Not reported	1 reps, 30/rep
Concentration 4 Nom; Meas (µg/L)	140; Not reported	1 reps, 30/rep
Concentration 5 Nom; Meas (µg/L)	180; Not reported	1 reps, 30/rep
Concentration 6 Nom; Meas (µg/L)	240; Not reported	1 reps, 30/rep
Concentration 7 Nom; Meas (µg/L)	320; Not reported	1 reps, 30/rep
Control	Dilution water	1 reps, 30/rep
LC <sub>50</sub> (95% CI) (µg/L)	24 h: >320 96 h: 200 (130-310)	Method: Probit, log, linear regression
NOEC	56 µg/L	Method: Not reported p: Not reported MSD: Not reported
LOEC	Not reported	
MATC (GeoMean NOEC, LOEC)	Not calculable	
% control at NOEC	100%	
% control at LOEC	Not calculable	

Notes: Results reported as the “incipient median tolerance limit (TL<sub>50</sub>), the concentration of the test compound in water causing 50% mortality with no additional significant response (<10%) during the final 48 hours of exposure. Calculated by converting concentrations tested and observed % mortalities to logs and probits, respectively then used to calculate the linear regression equation.” This is taken to be equivalent to LC<sub>50</sub>.

Solubility (S) = 176.8 µg/L, 2S = 353.6 µg/L so all exposures are acceptable.

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Alkalinity (2), Conductivity (2), Photoperiod (3), Significance level (2), Minimum significant difference (2).  
Total: 100-18 = 82

Acceptability: Measured concentrations within 20% of nominal (4), Organisms randomized (1), Feeding (3), Acclimation (1), Alkalinity (2), Conductivity (1), Photoperiod (2), Concentrations not > 2x solubility (4), Random design (2), Replication (2), Minimum significant difference (1), % control at LOEC (1). Total: 100-24=76

**Reliability score: mean(82,76)=79**

## Water Toxicity Data Summary

### *Navicula pelliculosa*

Study: Roshon, R. 2002c. Oxyfluorfen (Goal): Growth inhibition test with the freshwater diatom, *Navicula pelliculosa*. ESG International, Inc., Guelph, Canada. ESG study ID # S2310-02. Submitted to Dow AgroSciences, LLC, Indianapolis, Indiana. Dow study ID # 021020 EPA MRID 45861105.

#### Relevance

Score: 100

Rating: R

#### Reliability

Score: 86.5

Rating: R

Relevance points taken off for:

	<b>Roshon 2002c</b>	<i>N. pelliculosa</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	FIFRA, 1982. Pesticide Assessment Guidelines, subdivision J. Hazard Evaluation: Non-target Plants. By R.W. Holst and T.C. Ellwanger. Office of Pesticide Programs. Washington, DC.  EPA, 1996, Ecological Effects Test Guidelines, OPPTS 850.5400, Algal Toxicity, Tiers I and II, EPA 712-C-96-164.	
Division	Heterokontophyta	
Class	Bacillariophyceae	
Order	Naviculales	
Family	Naviculaceae	
Genus	<i>Navicula</i>	
Species	<i>pelliculosa</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	5 d	
Source of organisms	University of Toronto Culture Collection (UTCC #552)	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	



	<b>Roshon 2002c</b>	<i>N. pelliculosa</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Animals randomized?	Not reported	
Test vessels randomized?	Not reported	
Test duration	120 h	
Data for multiple times?	Yes	0, 24, 48, 72, 96, 120 h
Effect 1:	Cell number	
Control response 1, mean x 10,000 (negative; solvent)	24 h: 1.31 (0.7), 1.94 (0.8) 48 h: 4.13 (1.7), 3.63 (1.1) 72 h: 10.19 (3.7), 13.25 (3.5) 96 h: 49.06 (17.0), 30.69 (10.6) 120h: 95.50 (27.2), 148.83 (40.8)	
Effect 2:	Area under growth curve	
Control response 2, mean x 10,000 (negative; solvent)	0-24 h: 3.63 (8.30), 11.52 (10.10) 24-48 h: 37.69 (25.53), 39.08 (20.49) 48-72 h: 128.76 (51.94), 155.66 (40.52) 72-96 h: 664.95 (238.27), 486.94 (146.07) 96-120 h: 2012.99 (551.34), 2541.79 (727.03) 0-72 h: 170.07 (83.31), 206.26 (62.83) 0-96 h: 835.02 (304.88), 693.20 (163.40) 0-120h: 2848.01 (841.15), 3230.84 (926.74)	
Effect 3:	Growth rate	
Control response 3, mean x 10,000 (negative; solvent)	0-24 h: 0.00614 (0.01845), 0.02253 (0.01701) 0-48 h: 0.02781 (0.00932), 0.02590 (0.00629) 0-72 h: 0.03290 (0.00473), 0.03692 (0.00430) 0-96 h: 0.04169 (0.00370), 0.03663 (0.00336) 0-120 h: 0.03725 (0.00246), 0.04127 (0.00234)	
Temperature	24 ± 2 °C	
Test type	Static	
Photoperiod/light intensity	Continuous, 4300 ± 15 %	

	<b>Roshon 2002c</b>	<i>N. pelliculosa</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
	lux	
Dilution water	Freshwater diatom nutrient solution	Modified from ASTM 1997 See Appendix C, p. 58
pH	7.5 ± 0.1	
Hardness	Not reported, dilution water standard used	ASTM 1997
Alkalinity	Not reported, dilution water standard used	ASTM 1997
Conductivity	Not reported, dilution water standard used	ASTM 1997
Dissolved Oxygen	Not reported, dilution water standard used	ASTM 1997
Feeding	Nutrient medium	
Purity of test substance	99.3 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	52-98	Only conc. #5 acceptable
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC-ECD	
Concentration of carrier (if any) in test solutions	Not reported	
Concentration 1 Nom; Meas (µg/L)	7.81, 5.10 < 20% nominal	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Concentration 2 Nom; Meas (µg/L)	15.63, 9.55 < 20% nominal	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Concentration 3 Nom; Meas (µg/L)	31.25, 18.30 < 20% nominal	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Concentration 4 Nom; Meas (µg/L)	62.50, 40.40 < 20% nominal	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Concentration 5 Nom; Meas (µg/L)	125.00, 122.45	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Concentration 6 Nom; Meas (µg/L)	250.00, 130.40 < 20% nominal	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Control 1 Nom; Meas (µg/L)	Nutrient, 0.0	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
Control 2 Nom; Meas (µg/L)	Solvent, 0.0	4 reps, 1 x 10 <sup>4</sup> cells/mL/rep
EC <sub>50</sub> (95% CI) (µg/L)	Effect 1 24 h: >130.40 48 h: 128.14	Method: Linear interpolation using TOXSTAT

	<b>Roshon 2002c</b>	<b><i>N. pelliculosa</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
	72 h: 35.68 96 h: 30.49 120 h: 29.01  Effect 2: 0-24 h: 52.59 24-48 h: 41.98 48-72 h: 33.85 72-96 h: 29.88 96-120 h: 28.92 0-72 h: 35.05 0-96 h: 30.84 0-120 h: 29.45  Effect 3: 0-24 h: 58.32 0-48 h: 129.45 0-72 h: 109.04 0-96 h: 89.99 0-120 h: 97.07	program
NOEC	Effect 1 24, 48 h: 130.40 72, 96, 120 h: 18.3  Effect 2: 0-24, 24-48 h: 130.40  48-72, 72-96, 96-120, 0-72, 0-96, 0-120 h: 18.30  Effect 3: 0-24 h: 130.40 0-48 h: 122.45 0-72, 0-96, 0-120 h: 18.30	Method: ANOVA p: not reported MSD: not reported
LOEC	Effect 1 24, 48 h: > 130.40 72, 96, 120 h: 40.40  Effect 2: 0-24 h: > 130.40 24-48 h: > 130.40  48-72, 72-96, 96-120, 0-72, 0-96, 0-120 h: 40.40  Effect 3:	Method: ANOVA p: not reported MSD: not reported

	<b>Roshon 2002c</b>	<b><i>N. pelliculosa</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
	0-24 h: > 130.40 0-48 h: 130.40 0-72, 0-96, 0-120 h: 40.40	
MATC (GeoMean NOEC, LOEC)	Effect 1: 24, 48 h: not calculable 72, 96, 120 h: 27.19  Effect 2: 0-24, 24-48 h: not calculable 48-72, 96-120, 0-72, 0-96, 0-120 h: 27.19  Effect 3: 0-24 h: not calculable 0-48 h: 126.36 0-72, 0-96, 0-120 h: 27.19	
Effect 1: % control at NOEC	24 h: 18.5 48 h: 54.9 72 h: 72.0 96 h: 77.7 120 h: 86.3	24 h (NOEC = 130.40 ) 0.3 (tmt) / mean of 1.31, 1.94 = 18.5 % 48 h (NOEC = 130.40 ) 2.13 (tmt) / mean of 4.13, 3.63 = 54.9 % 72 h (NOEC = 18.3) 8.44 (tmt) / mean of 10.19, 13.25 = 72.0 % 96 h (NOEC = 18.3) 31.00 (tmt) / mean of 49.06, 30.69 = 77.7 % 120 h (NOEC = 18.3 ) 105.44 (tmt) / mean of 95.50, 148.83 = 86.3 %
Effect 1: % control at LOEC	24, 48 h: not calculable 72 h: 46.2 96 h: 41.2 120 h: 37.8	72 h (LOEC = 40.40) 5.41 (tmt) / mean of 10.19, 13.25 = 46.2 % 96 h (LOEC = 40.40) 16.44 (tmt) / mean of 49.06, 30.69 = 41.2 %

	Roshon 2002c	<i>N. pelliculosa</i>
Parameter	Value	Comment
		120 h (LOEC = 40.40 ) 46.06 (tmt) / mean of 95.50, 148.83 = 37.8 %
Effect 2: % control at NOEC	0-24 h: -4.2 24-48 h: 31.2 48-72 h: 76.2 72-96 h: 75.5 96-120 h: 83.4 0-72 h: 77.7 0-96 h: 76.0 0-120 h: 76.7	0-24 h (NOEC = 130.40) -0.32 (tmt) / mean of 3.63, 11.52 = -4.2 % 24-48 h (NOEC = 130.40) 11.96 (tmt) / mean of 37.69, 39.08 = 31.2 % 48-72 h (NOEC = 18.30 ) 108.41 (tmt) / mean of 128.76, 155.66 = 76.2 % 72-96 h (NOEC = 18.30) 434.63 (tmt) / mean of 664.95, 486.94 = 75.5 % 96-120 h (NOEC = 18.30) 1898.22 (tmt) / mean of 2012.99, 2541.79 = 83.4% 0-72 h (NOEC = 18.30 ) 146.16 (tmt) / mean of 170.07, 206.26 = 77.7 % 0-96 h (NOEC = 18.30) 580.79 (tmt) / mean of 835.02, 693.20 = 76.0 % 0-120 h (NOEC = 18.30) 2479.01 (tmt) / mean of 2848.01, 3230.84 = 76.7 %
Effect 2: % control at LOEC	0-24 h: not calculable 24-48 h: 30.6 48-72 h: 42.0 72-96 h: 47.3 96-120 h: 33.6 0-72 h: 46.5 0-96 h: 42.7	24-48 h (LOEC = 130.40) 11.96 (tmt) / mean of 37.69, 39.08 = 30.6 % 48-72 h (LOEC = 40.40) 65.43 (tmt) / mean of 128.76,

	Roshon 2002c	<i>N. pelliculosa</i>
Parameter	Value	Comment
	0-120 h: 38.8	155.66 = 42.0 % 72-96 h (LOEC = 40.40 ) 230.10 (tmt) / mean of 664.95, 486.94 = 47.3 % 96-120 h (LOEC = 40.40) 853.86 (tmt) / mean of 2012.99, 2541.79= 33.6 % 0-72 h (LOEC = 40.40) 95.81(tmt) / mean of 170.07, 206.26 = 46.5 % 0-96 h (LOEC = 40.40 ) 325.91 (tmt) / mean of 835.02, 693.20 = 42.7 % 0-120 h (LOEC = 40.40) 1179.76 (tmt) / mean of 2848.01, 3230.84= 38.8 %
Effect 3: % control at NOEC	Effect 3: 0-24 h: -15.6 0-48 h: 66.6 0-72 h: 87.7 0-96 h: 93.7 0-120 h: 97.7	0-24 h (NOEC = 130.40) -0.002253 (tmt) / mean of 0.00641, 0.02253= -15.6 % 0-48 h (NOEC = 122.45) 0.01788 (tmt) / mean of 0.02781, 0.02590 = 66.6 % 0-72 h (NOEC = 18.30 ) 0.03063 (tmt) / mean of 0.03290, 0.03692 = 87.7 % 0-96 h (NOEC = 18.30 ) 0.03669 (tmt) / mean of 0.04169, 0.03663 = 93.7 % 0-120 h (NOEC = 18.30 ) 0.03848 (tmt) / mean of 0.03752, 0.04127 =

	<b>Roshon 2002c</b>	<b><i>N. pelliculosa</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
		97.7 %
Effect 3: % control at LOEC	Effect 3: 0-24 h: not calculable 0-48 h: 52.4 0-72 h: 73.2 0-96 h: 73.5 0-120 h: 76.0	0-48 h (LOEC = 130.40) 0.01407 (tmt) / mean of 0.02781, 0.02590 = 52.4% 0-72 h (LOEC = 40.40) 0.02254 (tmt) / mean of 0.03290, 0.03692 = 73.2% 0-96 h (LOEC = 40.40 ) 0.02878 (tmt) / mean of 0.04169, 0.03663 = 73.5 % 0-120 h (LOEC = 40.40 ) 0.02993 (tmt) / mean of 0.03752, 0.04127 = 76.0%

Notes: Most % control at LOEC/NOEC are low and would be considered unacceptable. This could be a particularly sensitive species.

Dilution water parameters were not described, although a standard preparation was used (ASTM, 1997), presumably at levels suitable for this particular species.

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Statistical significance (2), Significance level (2), Minimum significant difference (2). Total: 100 – 6 = 94

Acceptability: Control response (9), Measured concentrations within 20% nominal (4), Organisms randomized (1), Random design (2), Dilution factor (2), Minimum significant difference (1), % control at NOEC (1), % control at LOEC (1). Total: 100 - 21 = 79

**Reliability score: mean (94, 79) = 86.5**

## Water Toxicity Data Summary

### *Pimephales promelas*

Study: Palmer, Susan J., Kendall, Timothy Z., Krueger, Henry O. 2005. Oxyfluorfen: An early life-stage toxicity test with the fathead minnow (*Pimephales promelas*) under ultraviolet light conditions. Wildlife International, Ltd. Project number: 379A-114. Down Agrosiences study number: 040442. Wildlife International, Ltd., Easton, Maryland. Submitted to the Dow Chemical Company, Midland, Michigan. CDPR study ID 218958.

#### Relevance

Score: 100

Rating: R

#### Reliability

Score: 93

Rating: R

Relevance points taken off for: none

	<b>Palmer et al. 2005</b>	<b><i>P. promelas</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	OECD Guideline 210, the US EPA series 850.1400 Guideline, and ASTM Standard E1241-98 Guideline under GLP	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	<i>Pimephales</i>	
Species	<i>promelas</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	2-24 h old	
Source of organisms	Chesapeake Cultures, Hayes, Virginia	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	5 d embryo hatching followed by 28 d post hatch	
Data for multiple times?	No	
Effect 1	Hatching success	
Control response 1 (negative/solvent)	94/99%	
Effect 2	Larval survival	
Control response 2	84/82%	



	Palmer et al. 2005	<i>P. promelas</i>
Parameter	Value	Comment
(negative/solvent)		
Effect 3	Length	
Control response 3 (negative/solvent)	21.6 ± 0.3 mm	Combined controls, 8 reps, 20 animals/rep
Effect 4	Wet weight	
Control response 4 (negative/solvent)	78.7 ± 2.2 mg	Combined controls, 8 reps, 20 animals/rep
Effect 5	Dry weight	
Control response 5 (negative/solvent)	13.55 ± 0.75 mg	Combined controls, 8 reps, 20 animals/rep
Temperature	25 ± 1 °C	
Test type	Flow through	
Photoperiod/light intensity	16l:8d	20 to 45 µW/cm <sup>2</sup> UVA and 5 to 13 µW/cm <sup>2</sup> UVB
Dilution water	Well water	40 ft deep, on-site
pH	8.2-8.4	
Hardness	133 (128-136, n = 4) mg/L CaCO <sub>3</sub>	
Alkalinity	179 (178-180, n = 4) mg/L CaCO <sub>3</sub>	
Conductivity	294 (290-300, n = 4) umhos/cm	
Dissolved Oxygen	6.7 mg/L, ≥82%	
Feeding	3 times/d for 7 d post-hatch, then 2 times/d, and unfed last 48 h	Live brine shrimp nauplii ( <i>Artemia</i> sp.)
Purity of test substance	99.3%	
Concentrations measured?	Initial, ~weekly, termination	
Measured is what % of nominal?	79-104% except d 28 only 33% due to diluter malfunction	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC/ECD	
Concentration of carrier (if any) in test solutions	0.1 mL/L dimethyl formamide	
Concentration 1 Nom; Meas (µg/L)	0.63; 0.55	4 reps, 20/rep
Concentration 2 Nom; Meas (µg/L)	1.3; 1.3	4 reps, 20/rep
Concentration 3 Nom; Meas (µg/L)	2.5; 2.4	4 reps, 20/rep
Concentration 4 Nom; Meas (µg/L)	5.0; 4.7	4 reps, 20/rep

	<b>Palmer et al. 2005</b>	<b><i>P. promelas</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Concentration 5 Nom; Meas (µg/L)	10; 8.0 < 20 % of nominal	4 reps, 20/rep
Control	Two controls: Negative (dilution water) and solvent (0.1 mL/L dimethyl formamide)	4 reps, 20/rep 4 reps, 20/rep No differences detected between controls ( $p \leq 0.05$ ) so pooled for analysis
NOEC (µg/L)	Effect 1: 1.3 Effect 2: 1.3 Effect 3: 1.3 Effect 4: 1.3 Effect 5: 1.3	Method: Fisher's Exact test $p \leq 0.05$ MSD: n/a
LOEC (µg/L)	Effect 1: 2.4 Effect 2: 2.4 Effect 3: not calculable Effect 4: not calculable Effect 5: not calculable	Method: Fisher's Exact test $p \leq 0.05$ MSD: n/a
MATC (GeoMean NOEC, LOEC, µg/L)	Effects 1 & 2: 1.8	
% control at NOEC	100%	Survival % at NOEC = 83 Survival of controls (mean) = 83 $83/83 * 100 = 100\%$
% control at LOEC	71%	Survival % at NOEC = 59 Survival of controls (mean) = 83 $59/83 * 100 = 71\%$

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All concentration exposures were below 2S and are therefore acceptable.

For effects 3, 4, and 5, a LOEC was not calculable because although there were higher concentrations tested, the higher concentration treatment groups were excluded from statistical analysis of growth since there were significant effects on survival in those treatment groups.

Reliability points taken off for:

Documentation: Minimum significant difference (2), Point estimates (8). Total: 100 - 10 = 90

Acceptability: Minimum significant difference (1), Point estimates (3). Total: 100 - 4 = 96

**Reliability score: mean(90, 96) = 93**

## **Appendix A2 – Wildlife Toxicity Studies Rated RR**

*A. platyrhynchos*. Frey et al. 2003

Frey, LT, Martin, KH, Beavers, JB, Jaber, M. 2003. Oxyfluorfen: A reproduction study with the mallard. Wildlife International, Ltd., Easton, Maryland. Wildlife International, Ltd. project number 379-128. Dow Agrosiences study number 021018. Submitted to The Dow Chemical Company, Midland, Michigan. EPA MRID 46070101.

Table 3.10 Documentation and acceptability rating for terrestrial laboratory/field data (adapted from ECOTOX 2006). Score is given if parameter is reported.

<b>Parameter<sup>1</sup></b>	<b>Score<sup>2</sup></b>	<b>Points</b>
Exposure duration	20	<b>20</b>
Control type	7	<b>7</b>
Organism information (i.e., age, life stage)	8	<b>8</b>
Chemical grade or purity	5	<b>5</b>
Chemical analysis method	5	<b>5</b>
Exposure type (i.e., dermal, dietary, gavage)	10	<b>10</b>
Test location (i.e., laboratory, field, natural artificial)	5	<b>5</b>
Application frequency	5	<b>5</b>
Organism source	5	<b>5</b>
Organism number and/or sample number	5	<b>5</b>
Dose number	5	<b>5</b>
Statistics		
Hypothesis tests		
Statistical significance	5	<b>5</b>
Significance level	5	<b>5</b>
Minimum significant difference	3	<b>0</b>
% of control at NOEC and/or LOEC	3	<b>2</b>
Point estimates (i.e., LC <sub>50</sub> , EC <sub>50</sub> )	4	<b>0</b>
<b>Total</b>	<b>100</b>	<b>93</b>

<sup>1</sup> Compiled from RIVM (2001), USEPA (1985; 2003b), ECOTOX (2006), CCME (1999), ANZECC & ARMCANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

<sup>2</sup> Weighting based acceptability criteria from various ASTM, OECD, APHA, and USEPA methods, ECOTOX (2006), and on data quality criteria in RIVM (2001), USEPA (1985; 2003b), CCME (1999), ANZECC & ARMCANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

## **Appendix A3 – Studies rated RL, LR, LL**

## Water Toxicity Data Summary

*Americamysis bahia*

Previously *M. bahia*

Study: Blankinship, AS, Kendall, TZ, Krueger, HO. 2005. Oxyfluorfen: A flow-through life-cycle toxicity test with the saltwater mysid (*Mysidopsis bahia*). Wildlife International, Ltd., project number: 379A-110A. Dow Agrosiences study number: 040441. USEPA OPPTS number 850.1350. Submitted to The Dow Chemical Company, Midland, Michigan. Wildlife International, Ltd., Easton, Maryland. EPA MRID 465977-01.

Relevance

Score: 85

Rating: L

Reliability

Score: 83.5

Rating: R

Relevance points taken off for: freshwater (15)

	<b>Blankinship et al. 2005</b>	<b><i>A. bahia</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	US EPA series 850.1350 Guideline and ASTM Standard E1191-97 Guideline under GLP.	
Phylum/subphylum	Crustacea	
Class	Malacostraca	
Order	Mysida	
Family	Mysidae	
Genus	<i>Americamysis</i>	
Species	<i>bahia</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Wildlife International, Ltd., Easton, Maryland	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	30 d	
Data for multiple times?	Yes	0,7,14, 21, 30 d
Effect 1	Survival	
Control response 1, mean (negative; solvent)	97.5%	Controls pooled
Effect 2	Reproduction	
Control response 2, mean (negative; solvent)	97%	Controls pooled

	<b>Blankinship et al. 2005</b>	<b><i>A. bahia</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 3	Growth, length; dry weight	
Control response 3, mean (negative; solvent)	Growth, length: 7.94 mm Growth, weight: 0.87 mg	Controls pooled
Temperature	25 ± 2 °C	
Test type	Flow-through	
Photoperiod/light intensity	16l : 8d (140 lux)	
Dilution water	Natural seawater diluted to 20 ppt salinity with well water	Indian River Inlet, Delaware, USA
pH	8.2-8.3	
Hardness	Not reported	
Salinity	19-20 ppt	
Conductivity	Not reported	
Dissolved Oxygen	6.5 mg/L	> 89%
Feeding	Live brine shrimp nauplii and Algamac 2000	1-4/d
Purity of test substance	99.3	
Concentrations measured?	Yes	
Measured is what % of nominal?	75-88	
Toxicity values calculated based on nominal or measured concentrations?	Mean measured	Measured days 0, 7, 14, 21, 30
Chemical method documented?	Yes	GC/ECD
Concentration of carrier (if any) in test solutions	0.1 mL/L dimethyl formamide	
Concentration 1 Nom; Meas (µg/L)	5; 4.4	4 reps, 10/rep
Concentration 2 Nom; Meas (µg/L)	10; 8.6	4 reps, 10/rep
Concentration 3 Nom; Meas (µg/L)	20; 16	4 reps, 10/rep
Concentration 4 Nom; Meas (µg/L)	40; 25	4 reps, 10/rep
Concentration 5 Nom; Meas (µg/L)	80; 60	4 reps, 10/rep
Control 1 Nom; Meas (µg/L)	Negative, 0; 0	4 reps, 10/rep
Control 2 Nom; Meas (µg/L)	Solvent, 0; 0	4 reps, 10/rep
NOEC	Overall: 8.6 µg/L Effect 1: 16 µg/L (0-15 d) Effect 1: 16 µg/L (16-30 d) Effect 2: 8.6 µg/L Effect 3: 16 µg/L	Method: ANOVA, Bonferroni's test p: 0.05 MSD: not reported
LOEC	Effect 1: not reported Effect 2: 16 µg/L Effect 3: 25 µg/L	
MATC (GeoMean NOEC, LOEC)	Effect 1: not calculable Effect 2: 12 µg/L Effect 3: 20 µg/L	
Effect 1: % control at NOEC	99	Survival: 97% / 97.5% = 99%

	<b>Blankinship et al. 2005</b>	<b><i>A. bahia</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1: % control at LOEC	Not calculable	
Effect 2: % control at NOEC	99	Reproduction: 96% / 97% = 99%
Effect 2: % control at LOEC	Not calculable	
Effect 3: % control at NOEC	Growth, length: 100 Growth, weight: 96	Length: 7.94 / 7.93 = 100 Weight: 8.39 / 8.7 = 96%
Effect 3: % control at LOEC	Not calculable	

Notes: Saltwater species so will be used as supplemental only.

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Hardness (2), Alkalinity (2), Conductivity (2), Minimum significant difference (2), Point estimates (8). Total: 100 – 16 = 84

Acceptability: Measured concentrations within 20% nominal (4), Hardness (2), Alkalinity (2), Temperature variation (3), Dilution factor (2), Minimum significant difference (1), Point estimates (3). Total: 100 - 17 = 83

**Reliability score: mean (84, 83) = 83.5**



## Water Toxicity Data Summary

### *Anabena flos-aquae*

Study: Giddings, J.M. 1990. Goal technical—toxicity to five species of aquatic plants. Springborn Laboratories, Inc., Wareham, Massachusetts. Reports # 90-08-3417. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 41618401.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 88

Rating: R

Relevance points taken off for: Chemical purity (15). 100-15=85

	<b>Giddings 1990</b>	<b><i>A. flos-aquae</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Protocol for conducting 5-day toxicity tests with freshwater and/or marine algae following FIFRA guideline 122-2 and 123-2	
Phylum/subphylum	Cyanobacteria	
Order	Nostocales	
Family	Nostocaceae	
Genus	<i>Anabena</i>	
Species	<i>Flos-aquae</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	3 d	
Source of organisms	Carolina Biological Supply Company, Burlington, North Carolina	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	3 d, yes	
Animals randomized?	Not reported	Given organism size and presence in growth medium, it is assumed that aliquots are inherently randomly
Test vessels randomized?	Not reported	
Test duration	120 h	
Data for multiple times?	24, 48, 72, 96, 120 h	
Effect 1:	Cell count	
Control response 1, x 10 <sup>4</sup> cells/mL, mean (negative; solvent)	24 h: 0 48 h: 3	

	<b>Giddings 1990</b>	<b><i>A. flos-aquae</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
	72 h: 7 96 h: 4 120 h: 18	
Temperature	25.5 ± 0.5 °C	
Test type	Static	
Photoperiod/light intensity	Continuous/1200-2200 lux	
Dilution water	Growth medium	Algal Assay Procedure medium prepared with deionized water
pH	7.5	
Feeding	Growth medium	
Purity of test substance	71.5 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	58-89 %	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC	
Concentration of carrier (if any) in test solutions	Acetone: 0.1 mL/L	
Concentration 1 Nom; Meas (µg/L)	190; 170	3 reps, 2760 cells/rep  920 µL at 0.3 x 10 <sup>4</sup> cells/mL
Concentration 2 Nom; Meas (µg/L)	390; 250	3 reps, 2760 cells/rep
Concentration 3 Nom; Meas (µg/L)	750; 440	3 reps, 2760 cells/rep
Concentration 4 Nom; Meas (µg/L)	1500; 1200	3 reps, 2760 cells/rep
Concentration 5 Nom; Meas (µg/L)	3000; 2000	3 reps, 2760 cells/rep
Control 1 Nom; Meas (µg/L)	Negative: 0; 0	3 reps, 2760 cells/rep
Control 2 Nom; Meas (µg/L)	Solvent: 0; 0	3 reps, 2760 cells/rep
EC <sub>50</sub> (µg/L)	> 2000	Method: linear regression
NOEC	2000	Method: ANOVA and Dunnett's Procedure p: 0.05 MSD: not reported

	<b>Giddings 1990</b>	<i>A. flos-aquae</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1: % control at NOEC	2.5 %	45 (tmt) / 18 (mean controls) = 2.5

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. Only two exposure concentrations were below 2S and where therefore acceptable.

Reliability points were not taken off for water quality parameters (hardness, alkalinity, conductivity) because there is no guidance for these parameters in the test guidelines for algal/plant studies, the growth medium used requires distilled water, and the medium is presumably appropriate for the test species because a specific culture media was used.

Reliability points taken off for:

Documentation: Statistical significance (2), Minimum significant difference (2). Total: 100-4=96

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Minimum significant difference (1), % control at NOEC (1), % control at LOEC (1), Point estimates (3). Total: 100-20 = 80

**Reliability score: mean(96,80)=88**

## Water Toxicity Data Summary

### *Ictalurus punctatus*

Study: Kuc, W.J. 1977. The acute toxicity of RH 2915 technical, lot # 7364 (74 % active ingredient) to channel catfish, *Ictalurus punctatus* (Rafinesque). Union Carbide Environmental Services, Tarrytown, New York. Project number 11508-33-02. Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 134448.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 71

Rating: L

Relevance points taken off for: Chemical purity (15). 100-15=85

	<b>Kuc 1977</b>	<b><i>I. punctatus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Recommended bioassay practices, EPA 1975	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Siluriformes	
Family	Ictaluridae	
Genus	<i>Ictalurus</i>	
Species	<i>Punctatus</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	3 months 58 mm 0.95 g	
Source of organisms	Commercial hatchery in North Carolina	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	24 h	
Animals randomized?	Yes	
Test vessels randomized?	Not reported	
Test duration	96 h	
Data for multiple times?	24, 48, 96 h	
Effect 1:	Survival	
Control response 1:	100 %	
Temperature	22 ± 1 °C	
Test type	Static	
Photoperiod/light intensity	Not reported	
Dilution water	Deionized well water	Reverse osmosis
pH	7.64	
Hardness	44 mg/L CaCO <sub>3</sub>	
Alkalinity	40 mg/L CaCO <sub>3</sub>	

	<b>Kuc 1977</b>	<b><i>I. punctatus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Conductivity	123 umhos/cm	
Dissolved Oxygen	8.4 – 2.0 mg/L	Control range (0 – 96 h) 96 – 23 %
Feeding	Off feed 48 prior to test initiation	
Purity of test substance	74 %	
Concentrations measured?	No	
Toxicity values calculated based on nominal or measured concentrations?	Nominal	
Concentration of carrier (if any) in test solutions	Acetone, concentration not reported	
Concentration 1 Nom; Meas (µg/L)	100; not reported	0 rep, 10/rep
Concentration 2 Nom; Meas (µg/L)	180; not reported	0 rep, 10/rep
Concentration 3 Nom; Meas (µg/L)	320; not reported	0 rep, 10/rep
Concentration 4 Nom; Meas (µg/L)	560; not reported	0 rep, 10/rep
Concentration 5 Nom; Meas (µg/L)	1000; not reported	0 rep, 10/rep
Control 1 Nom; Meas (µg/L)	Solvent, 0; not reported	0 rep, 10/rep
Control 2 Nom; Meas (µg/L)	Negative, 0; not reported	0 rep, 10/rep
LC <sub>50</sub> (95% CI) (µg/L)	400 (360 – 450)	Method:
NOEC	180	Method: p: MSD: not reported NOEC based on abnormal behavior
Effect 1: % control at NOEC	100 %	

Notes: Study states that NOEC based on abnormal behavior instead of survival. The study does not include any description of statistical analysis or raw data on the “abnormal behavior.”

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. Only 3 exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Photoperiod (3), Statistics method (5), Statistical significance (2), Significance level (2), Minimum significant difference (2). Total: 100-21=79

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Concentrations not > 2x solubility (4), Carrier solvent (4), Adequate organisms per rep (2), Photoperiod (2), Number of concentrations (3), Random design (2), Adequate replication (2), Statistical method (2), Minimum significant difference (1), % control at LOEC (1). Total: 100-37=63

**Reliability score: mean(79,63)=71**

## Water Toxicity Data Summary

### *Daphnia magna*

Study: Godfrey, W.J., Longacre, S.L. 1990a. Phase 3 summary of Goal technical herbicide (oxyfluorfen) chronic toxicity to *Daphnia magna*. Analytical Biochemistry Laboratories, Inc., Columbia, Missouri. Laboratory report 33943. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 92136094.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 75

Rating: R

Relevance points taken off for: Chemical purity (15). 100-15=85

	Godfrey & Longacre 1990a	<i>D. magna</i>
Parameter	Value	Comment
Test method cited	Method patterned after ASTM, USEPA, Organization for Economic Cooperation and Development procedures	
Phylum/subphylum	Arthropoda/Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Daphnia</i>	
Species	<i>magna</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Laboratory	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Not reported	
Test duration	21 d	
Data for multiple times?	No	
Effect 1:	Length	
Control response 1, mean (negative; solvent)	3.4 mm	
Effect 2:	Survival	
Control response 2, mean (negative; solvent)	92 %	
Effect 3:	Reproduction (young/adult)	

	Godfrey & Longacre 1990a	<i>D. magna</i>
Parameter	Value	Comment
Control response 3, mean (negative; solvent)	>4.8	
Temperature	20 ± 1 °C	
Test type	Flow through	
Photoperiod/light intensity	16l:8d/50-70 footcandles	
Dilution water	Well water	
pH	8.1-8.4	
Dissolved Oxygen	8.4-9.1 mg/L	94-102%
Feeding	Algae ( <i>R. subcapitata</i> ) 3/d, Tetramin-cerophyl 1/d	Suspensions
Purity of test substance	71.8 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	49-72 %	Attributed to adsorption to glass test vessels
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	Not reported	
Concentration of carrier (if any) in test solutions	Triethylene glycol	
Concentration 1 Nom; Meas (µg/L)	3.7; 1.8	4 reps, 10/rep
Concentration 2 Nom; Meas (µg/L)	6; 4.3	reps
Concentration 3 Nom; Meas (µg/L)	14; 7.4	reps
Concentration 4 Nom; Meas (µg/L)	24; 13	reps
Concentration 5 Nom; Meas (µg/L)	50; 28	reps
Control 1 Nom; Meas (µg/L)	Negative: 0; 0	reps
Control 2 Nom; Meas (µg/L)	Solvent: 0; 0	reps
NOEC	13	Method: ANOVA p: 0.05 MSD: Not reported
LOEC	28	
MATC (GeoMean NOEC, LOEC)	19	
Effect 1: % control at NOEC	Length: 79%	NOEC = 28 2.7 (tmt) / 3.4 (mean controls) =
Effect 1: % control at LOEC	Length: 100%	LOEC = 13 3.4 (tmt) / 3.4 (mean controls) = 100 %
Effect 2: % control at NOEC	Survival: 81.5 %	NOEC = 28 75 (tmt) / 92 (mean controls) = 81.5
Effect 2: % control at LOEC	Survival: 103 %	LOEC = 13

	<b>Godfrey &amp; Longacre 1990a</b>	<b><i>D. magna</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
		95 (tmt) / 92 (mean controls) = 103 %
Effect 3: % control at NOEC	Reproduction: 25%	NOEC = 28 1.2 (tmt) / 4.8 (mean controls) = 25%
Effect 3: % control at LOEC	Reproduction: 92%	LOEC = 13 4.4 (tmt) / 4.8 (mean controls) = 92 %

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Hardness (2), Alkalinity (2), Conductivity (2), Statistical significance (2), Minimum significant difference (2), Point estimates (8). Total: 100-18 = 82

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Carrier solvent (4), Feeding (3), Hardness (2), Alkalinity (2), Conductivity (1), Random design (2), Minimum significant difference (1), Point estimates(3). Total: 100-32 = 68

**Reliability score: mean(82,68)=75**



## Water Toxicity Data Summary

### *Lemna gibba*

Study: Giddings, J.M. 1990. Goal technical—toxicity to five species of aquatic plants. Springborn Laboratories, Inc., Wareham, Massachusetts. Reports # 90-08-3417. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 41618401.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 82.5

Rating: R

Relevance points taken off for: Chemical purity (15).  $100 - 15 = 85$

	<b>Giddings 1990</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Protocol for conducting 5-day toxicity tests with freshwater and/or marine algae following FIFRA guideline 122-2 and 123-2	
Order	Alismatales	
Family	Araceae	
Genus	<i>Lemna</i>	
Species	<i>gibba</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	8 d	
Source of organisms	Charles F. Cleland, USDA, Washington, DC	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	8 d, yes	
Animals randomized?	Not reported	
Test vessels randomized?	Yes	
Test duration	14 d	
Data for multiple times?	3, 6, 9, 12, 14 d	
Effect 1:	Frond growth	
Control response 1, mean (negative; solvent)	24 h: 36 48 h: 83 72 h: 181 96 h: 302 120 h: 437	
Temperature	$21 \pm 1$ °C	
Test type	Static	
Photoperiod/light intensity	16l : 8 d/4000-5000 lux	
Dilution water	Growth medium	Hoagland's M-Type

	<b>Giddings 1990</b>	<b><i>L. gibba</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
		medium prepared with deionized water
pH	7.5	
Feeding	Growth medium	
Purity of test substance	71.5 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	31-86 %	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC	
Concentration of carrier (if any) in test solutions	Acetone: 0.1 mL/L	
Concentration 1 Nom; Meas (µg/L)	1.3; 0.72	3 reps, 5 plants of 3 fronds/rep
Concentration 2 Nom; Meas (µg/L)	2.6; 1.2	3 reps, 5 plants of 3 fronds/rep
Concentration 3 Nom; Meas (µg/L)	5.0; 4.3	3 reps, 5 plants of 3 fronds/rep
Concentration 4 Nom; Meas (µg/L)	20; 6.2	reps, 5 plants of 3 fronds/rep
Control 1 Nom; Meas (µg/L)	Negative: 0; 0	3 reps, 5 plants of 3 fronds/rep
Control 2 Nom; Meas (µg/L)	Solvent: 0; 0	3 reps, 5 plants of 3 fronds/rep
EC <sub>50</sub> (95% CI) (µg/L)	1.4 (0.87 – 2.4)	Method: linear regression
NOEC	< 0.72	Method: ANOVA and Dunnett's Procedure p: 0.05 MSD: not reported
Effect 1: % control at NOEC	Not calculable	

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and were therefore acceptable.

Reliability culture media was used.

Reliability points taken off for:

Documentation: Statistical significance (2), Minimum significant difference (2), % control at NOEC/LOEC (2). Total: 100- 6=94

Acceptability: Control response (9), Chemical purity (10), Measured concentrations within 20% nominal (4), Number of concentrations (3), Minimum significant difference (1), % control at NOEC (1), % control at LOEC (1). Total: 100-29 = 71

**Reliability score: mean(94,71)=82.5**



## Water Toxicity Data Summary

### *Lepomis macrochirus*

Study: Graves, W.C., Smith, G.J. 1991a. Goal technical herbicide: a 96-hour status acute toxicity test with the bluegill (*Lepomis macrochirus*). Wildlife International, Ltd. Project number 129A-103A. Rohm and Haas report number 90RC-0097. Submitted to Rohm and Haas, Spring House, Pennsylvania. Wildlife International, Ltd. Easton, Maryland. EPA MRID 42129801.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 82.5

Rating: R

Relevance points taken off for: chemical purity (15)

	<b>Graves and Smith 1991a</b>	<b><i>L. macrochirus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Series 72 of <i>Pesticide Assessment Guidelines, Subdivision E Hazard Evaluation: Wildlife and Aquatic Organisms</i> and ASTM Standard E 729-88 <i>Standard Practice for Conducting Acute Toxicity Tests with Fishes, Macroinvertebrates and Amphibians</i>	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Perciformes	
Family	Centrarchidae	
Genus	<i>Lepomis</i>	
Species	<i>macrochirus</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	Juveniles, 0.3 g (0.23-0.40 g), 23 mm (22-26 mm)	
Source of organisms	Delmarva Ecological Laboratories, Middletown, Delaware	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	51 h
Animals randomized?	Yes	
Test vessels randomized?	Not reported	
Test duration	96 h	
Data for multiple times?	Yes	3.5, 24, 48, 72, 96 g

	<b>Graves and Smith 1991a</b>	<b><i>L. macrochirus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1:	Mortality	
Control response 1, mean (negative; solvent)	0; 0%	
Temperature	Holding: $21 \pm 0.6$ °C Test: $22 \pm 1$ °C	
Test type	Flow-through changed to static	
Photoperiod/light intensity	16l:8d, 100 footcandles	Ambient room light from fluorescent tubes with l/d transition
Dilution water	Well water	
pH	7.4-8.5	
Hardness	148 mg/L CaCO <sub>3</sub>	
Alkalinity	194 mg/L CaCO <sub>3</sub>	
Conductivity	330 umhos/cm	
Dissolved Oxygen	>60% through 48 h	<60% in negative control and concentrations 1, 3, 4,5 by 96 h
Feeding	Fed during holding until 48 h prior to test: flaked fish food, salmon mash, and/or salmon starter (Zeigler); live brine shrimp nauplii (Artemia)	Zeigler Brothers, Inc., Gardners, Pennsylvania; Artemia, Inc., Newark, California
Purity of test substance	71.4%	
Concentrations measured?	Yes	
Measured is what % of nominal?	47-73%	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC	
Concentration of carrier (if any) in test solutions	0.08 mL/L	
Concentration 1 Nom; Meas (µg/L)	62; 29	2reps, 10/rep
Concentration 2 Nom; Meas (µg/L)	103; 54	2reps, 10/rep
Concentration 3 Nom; Meas (µg/L)	171; 93	2reps, 10/rep
Concentration 4 Nom; Meas (µg/L)	286; 175	2reps, 10/rep
Concentration 5 Nom; Meas (µg/L)	476; 346 measured <2S	2reps, 10/rep
Control 1, Negative, dilution water	0;2 (LOD)	2reps, 10/rep
Control 2, Solvent, 0.08 mL/L acetone	0; 2 (LOD)	2reps, 10/rep
LC <sub>50</sub> (95% CI) (µg/L)	210 µg/L (180 - 350)	Method: binomial
NOEC	93 µg/L	Method:

	Graves and Smith 1991a	<i>L. macrochirus</i>
Parameter	Value	Comment
		p: MSD:
% control at NOEC	100%	Survival: 100% control / 100% NOEC = 100%
control at LOEC	Not calculable	

Notes: Although dissolved oxygen levels fell <60% in the negative control and concentrations 1, 3, 4,5 by 96 h, study discussion states that it did not appear to have an effect on the results of the study.

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All measured exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Chemical purity (5), Statistical significance (2), Significance level (2), Minimum significant difference (2). Total: 100 - 11 = 89

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Dissolved oxygen (6), Random design (2), Minimum significant difference (1), % control at NOEC (1). Total: 100 - 24 = 76

**Reliability score: mean (89, 76) = 82.5**

## Water Toxicity Data Summary

### *Navicula pelliculosa*

Study: Giddings, J.M. 1990. Goal technical—toxicity to five species of aquatic plants. Springborn Laboratories, Inc., Wareham, Massachusetts. Reports # 90-08-3417. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 41618401.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 92

Rating: R

Relevance points taken off for: Chemical purity (15).  $100 - 15 = 85$

	<b>Giddings 1990</b>	<b><i>N. pelliculosa</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Protocol for conducting 5-day toxicity tests with freshwater and/or marine algae following FIFRA guideline 122-2 and 123-2	
Division	Heterokontophyta	
Class	Bacillariophyceae	
Order	Naviculales	
Family	Naviculaceae	
Genus	<i>Navicula</i>	
Species	<i>pelliculosa</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	2 d	
Source of organisms	Carolina Biological Supply Company, Burlington, North Carolina	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	2 d, yes	
Animals randomized?	Not reported	Given organism size and presence in growth medium, it is assumed that aliquots are inherently randomly
Test vessels randomized?	Yes	
Test duration	120 h	
Data for multiple times?	24, 48, 72, 96, 120 h	
Effect 1:	Cell count	
Control response 1, x 10 <sup>4</sup> cells/mL,	24 h: 1	



	<b>Giddings 1990</b>	<b><i>N. pelliculosa</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
mean (negative; solvent)	48 h: 1 72 h: 13 96 h: 27 120 h: 63	
Temperature	25.5 ± 0.5 °C	
Test type	Static	
Photoperiod/light intensity	Continuous/3500-4000 lux	
Dilution water	Growth medium	Algal Assay Procedure medium prepared with deionized water
pH	7.5	
Feeding	Growth medium	
Purity of test substance	71.5 %	
Concentrations measured?	Measured	
Measured is what % of nominal?	77-101 %	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC	
Concentration of carrier (if any) in test solutions	Acetone: 0.1 mL/L	
Concentration 1 Nom; Meas (µg/L)	0.099; 0.10	3 reps, 2820 cells/rep  940 µL at 0.3 x 10 <sup>4</sup> cells/mL
Concentration 2 Nom; Meas (µg/L)	0.20; 0.18	3 reps, 2820 cells/rep
Concentration 3 Nom; Meas (µg/L)	0.42; 0.40	3 reps, 2820 cells/rep
Concentration 4 Nom; Meas (µg/L)	0.80; 0.62	3 reps, 2820 cells/rep
Concentration 5 Nom; Meas (µg/L)	1.6; 1.4	3 reps, 2820 cells/rep
Control 1 Nom; Meas (µg/L)	Negative: 0; 0	3 reps, 2820 cells/rep
Control 2 Nom; Meas (µg/L)	Solvent: 0; 0	3 reps, 2820 cells/rep
EC <sub>50</sub> (95% CI) (µg/L)	0.24 (0.066 – 0.82)	Method: linear regression
NOEC	0.10	Method: ANOVA and Dunnett's Procedure p: 0.05

	<b>Giddings 1990</b>	<i>N. pelliculosa</i>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
		MSD: not reported
Effect 1: % control at NOEC	98 %	62 (tmt) / 63 (mean controls) = 98 %

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and were therefore acceptable.

Reliability points were not taken off for water quality parameters (hardness, alkalinity, conductivity) because there is no guidance for these parameters in the test guidelines for algal/plant studies, the growth medium used requires distilled water, and the medium is presumably appropriate for the test species because a specific culture media was used.

Reliability points taken off for:

Documentation: Statistical significance (2), Minimum significant difference (2). Total: 100-4=96

Acceptability: Chemical purity (10), Minimum significant difference (1), % control at LOEC (1). Total: 100-12 = 88

**Reliability score: mean(96,88)=92**

## Water Toxicity Data Summary

### *Oncorhynchus mykiss*

Study: Graves, W.C., Smith, G.J. 1991b. Goal technical herbicide: a 96-hour static acute toxicity test with the rainbow trout (*Oncorhynchus mykiss*). Wildlife International, Ltd, project number 129A-102. Rohm and Haas report number 90RC-0098. Wildlife International, Ltd., Easton, Maryland. Presented to Rohm and Haas, Spring House, Pennsylvania. EPA MRID 42129802.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 84.5

Rating: R

Relevance points taken off for: chemical purity (15)

	<b>Graves &amp; Smith 1991b</b>	<b><i>O. mykiss</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Series 72 of <i>Pesticide Assessment Guidelines, Subdivision E Hazard Evaluation: Wildlife and Aquatic Organisms</i> and ASTM Standard E 729-88 <i>Standard Practice for Conducting Acute Toxicity Tests with Fishes, Macroinvertebrates and Amphibians</i>	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Salmoniformes	
Family	Salmonidae	
Genus	<i>Oncorhynchus</i>	
Species	<i>mykiss</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	Juveniles Wet weight: 0.5 g (0.37-0.63) Length: 30 mm (27-31 mm)	
Source of organisms	Mount Lassen Trout Farm, Red Bluff, California	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	52 h
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	

	<b>Graves &amp; Smith 1991b</b>	<b><i>O. mykiss</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Data for multiple times?	Yes	4.5, 24, 48, 72, 96 h
Effect	Mortality	
Control response, mean (negative; solvent)	0; 0%	
Temperature	12 ± 1 °C	
Test type	Static	
Photoperiod/light intensity	16l:8d, 70 footcandles	Ambient room light, l/d transition
Dilution water	Well water	
pH	Holding: 7-8	
Hardness	Holding: 144-160 mg/L CaCO <sub>3</sub>	
Alkalinity	Holding: 194 mg/L CaCO <sub>3</sub>	
Conductivity	Holding: 338 umhos/cm	330-3540
Dissolved Oxygen	9.5-11.9 mg/L > 60%	Difficult to read in study
Feeding	Salmon mash and/or salmon starter to within 48 h of test	Zeigler Brothers, Inc, Gardners, Pennsylvania
Purity of test substance	71.4 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	42-76	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	Yes, but cannot read text in study	
Concentration of carrier (if any) in test solutions	0.1 mL/L acetone	
Concentration 1 Nom; Meas (µg/L)	890; 370	2 reps, 10/rep
Concentration 2 Nom; Meas (µg/L)	179; 83	2 reps, 10/rep
Concentration 3 Nom; Meas (µg/L)	357; 175	2 reps, 10/rep
Concentration 4 Nom; Meas (µg/L)	714; 398 >2S	2 reps, 10/rep
Concentration 5 Nom; Meas (µg/L)	1430; 1090 >2S	2 reps, 10/rep
Control 1 Nom; Meas (µg/L)	Negative, dilution water	2 reps, 10/rep
Control 2 Nom; Meas (µg/L)	Solvent, 0.1 mL/L	2 reps, 10/rep
LC <sub>50</sub> (95% CI) (µg/L)	250 (190-360)	Method: binomial
NOEC	370 µg/L	Method: p: MSD:
% control at NOEC	100	Survival: 100% control / 100% NOEC = 100%
% control at LOEC	Not calculable	

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Chemical purity (5), Statistical significance (2), Significance level (2), Minimum significant difference (2). Total:  $100 - 11 = 89$

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Concentrations not > 2x solubility (4), Minimum significant difference (1), % control at LOEC (1). Total:  $100 - 20 = 80$

**Reliability score: mean (89, 80) = 84.5**

## Water Toxicity Data Summary

### *Palaemonetes pugio*

Study: Vilkas, A.G. 1977. Acute toxicity of RH 2915 technical, lot # 7364 (74 % active ingredient) to the grass shrimp, *Palaemonetes pugio*. Union Carbide Environmental Services, Tarrytown, New York. Project number 11506-3302. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 134451.

#### Relevance

Score: 70

Rating: L

#### Reliability

Score: 65.5

Rating: L

Relevance points taken off for: Freshwater (15), Chemical purity (15). 100-30=70

	<b>Vilkas 1977</b>	<b><i>P. pugio</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	The Committee on Methods for Toxicity Tests with Aquatic Organisms (1975)	
Phylum/subphylum	Arthropoda/crustacea	
Class	Malacostraca	
Order/ infraorder	Decapoda/caridea	
Family	Palaemonidae	
Genus	<i>Palaemonetes</i>	
Species	<i>Pugio</i>	
Family native to North America?	Yes	Western Atlantic and Gulf of Mexico
Age/size at start of test/growth phase	2.75 cm 0.33 g	
Source of organisms	Commercial supplier in Florida	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	14 d	
Animals randomized?	Not reported	
Test vessels randomized?	Not reported	
Test duration	96 h	
Data for multiple times?	24, 48, 96 h	
Effect 1:	Survival	
Control response 1, mean (negative; solvent)	100 %	
Temperature	18 °C	
Test type	Static	
Photoperiod/light intensity		
Dilution water	Artificial sea water from	Method of

	Vilkas 1977	<i>P. pugio</i>
Parameter	Value	Comment
	well water	Zaroogian et al., 1969 Salinity: 28.0 ‰
pH	7.97	
Feeding	Not fed for 48 h prior to test	
Purity of test substance	74 %	
Concentrations measured?	No	
Measured is what % of nominal?	Not measured	
Toxicity values calculated based on nominal or measured concentrations?	Nominal	
Chemical method documented?	Not measured	
Concentration of carrier (if any) in test solutions	Acetone, concentration not reported	
Concentration 1 Nom; Meas (µg/L)	10; not reported	0 reps, 10/rep
Concentration 2 Nom; Meas (µg/L)	18; not reported	0 reps, 10/rep
Concentration 3 Nom; Meas (µg/L)	32; not reported	0 reps, 10/rep
Concentration 4 Nom; Meas (µg/L)	56; not reported	0 reps, 10/rep
Concentration 5 Nom; Meas (µg/L)	100; not reported	0 reps, 10/rep
Control 1 Nom; Meas (µg/L)	Negative: 0; not reported	0 reps, 10/rep
Control 2 Nom; Meas (µg/L)	Solvent: 0; not reported	0 reps, 10/rep
LC <sub>50</sub> (95% CI) (µg/L)	31.7 (26.1 – 38.4)	Method: Spearman-Kärber Estimator
NOEC	18	Method: Not reported p: not reported MSD: not reported
Effect 1: % control at NOEC	100 %	

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and were therefore acceptable.

Reliability points taken off for:

Documentation: Measured concentrations (3), Temperature (4), Statistics method (5), % control at NOEC/LOEC (2), Point estimates (8). Total: 100-25=78

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Concentrations not > 2x solubility (4), Carrier solvent (4), Organisms randomized (1), Adequate organisms per rep (2), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Temperature variation (3), Conductivity (1), Photoperiod (2), Random design (2), Adequate replication (2), Minimum significant difference (1), % control at LOEC (1). Total: 100-47=53

**Reliability score: mean(78,53)=65.5**

## Water Toxicity Data Summary

### *Pimephales promelas*

Study: Godfrey, WJ, Longacre, SL. 1990b. Phase 3 summary of MRID 99270: Goal Technical Herbicide (oxyfluorfen)—Acute toxicity to fathead minnow eggs and fry—Report 80-RC-015. Springborn Life Sciences, Inc., Environmental Toxicology and Chemistry Division, Project BW-79-7-523. EPA MRID 92136057.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 77.5

Rating: R

Relevance points taken off for: Chemical purity (15). 100-15=85

	<b>Godfrey &amp; Longacre 1990b</b>	<b><i>P. promelas</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Methods for conducting early life stage toxicity tests with fathead minnow ( <i>Pimephales promelas</i> ) by EG&G Bionomics	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	<i>Pimephales</i>	
Species	<i>promelas</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	0.1 g, 22 mm long, < 24 h old	
Source of organisms	Minnow culture unit, EG&G Bionomics, Wareham, Massachusetts	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Not reported	
Test duration	Eggs: within 48 h after fertilization until hatching complete Fry: 30 d post-hatch	
Data for multiple times?	No	
Effect 1:	% hatch	
Control response 1, mean (negative; solvent)	87.5; 87.5	



	<b>Godfrey &amp; Longacre 1990b</b>	<b><i>P. promelas</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 2:	% survival	
Control response 2, mean (negative; solvent)	90; 90	
Effect 3:	Length (mm)	
Control response 3, mean (negative; solvent)	20; 20	
Effect 4:	Weight (mg)	
Control response 4, mean (negative; solvent)	62.5; 63	
Temperature	25 °C	Range not reported
Test type	Flow-through	
Photoperiod/light intensity	12L:12d, 20-100 footcandles	
Dilution water	Well water mixed with untreated/unchlorinated municipal; aerated	
pH	7.2-8.2	
Hardness	25-40 mg/L CaCO <sub>3</sub>	
Alkalinity	Not reported	
Conductivity	120-170 umhos/cm	
Dissolved Oxygen	8.1 ±0.4 mg/L	~97%
Feeding	Live brine shrimp	3/d weekdays 2/d weekends
Purity of test substance	71%	
Concentrations measured?	No	
Measured is what % of nominal?	Not applicable	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	Not applicable	
Concentration of carrier (if any) in test solutions	Triethylene glycol, 18.5 µL/L	
Concentration 1 Nom; Meas (µg/L)	12; 10	2 reps, 40/rep
Concentration 2 Nom; Meas (µg/L)	25; 20	2 reps, 40/rep
Concentration 3 Nom; Meas (µg/L)	50; 38	2 reps, 40/rep
Concentration 4 Nom; Meas (µg/L)	100; 74	2 reps, 40/rep
Concentration 5 Nom; Meas (µg/L)	200; 160	2 reps, 40/rep
Control 1 Nom; Meas (µg/L)	Dilution water, 0; < 0.9	2 reps, 40/rep
Control 2 Nom; Meas (µg/L)	Solvent, triethylene glycol, 18.5 µL/L, 0; < 0.4	2 reps, 40/rep
NOEC	38 µg/L	Method: probit p: not reported MSD: not reported
LOEC	74	
MATC (GeoMean NOEC, LOEC)	53	

	<b>Godfrey &amp; Longacre 1990b</b>	<b><i>P. promelas</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1: % control at NOEC	91	Hatch: 79.5 (tmt) / 87.5 (mean controls) = 91%
Effect 1: % control at LOEC	86	75 (tmt) / 87.5 (mean controls) = 86
Effect 2: % control at NOEC	36	Survival: 32.5 (tmt) / 90 (mean controls) = 36%
Effect 2: % control at LOEC	5.5	5 (tmt) / 90 (mean controls) = 6
Effect 3: % control at NOEC	97.5	Length: 19.5 (tmt) / 20 (mean controls) = 97.5%
Effect 3: % control at LOEC	70	14 (tmt) / 20 (mean controls) = 70%
Effect 4: % control at NOEC	101	Weight: 63.5% / 62.75% = 101%
Effect 4: % control at LOEC	Not calculable	

Notes: LC<sub>50</sub> value not stated in report, although the statistical analysis for its calculation is discussed. Report only includes tables 6 & 7 so there is data missing in available copy.

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points taken off for:

Documentation: Analytical method (4), Alkalinity (2), Statistical significance (2), Significance level (2), Minimum significant difference (2). Total: 100 - 20 = 80

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Temperature variation (3), Random design (2), Dilution factor (2), Minimum significant difference (1), Point estimates (3). Total: 100 - 25 = 75

**Reliability score: mean (80, 75) = 77.5**

## Water Toxicity Data Summary

### *Raphidocelis subcapitata*

Study: Giddings, J.M. 1990. Goal technical—toxicity to five species of aquatic plants. Springborn Laboratories, Inc., Wareham, Massachusetts. Reports # 90-08-3417. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 41618401.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 92

Rating: R

Relevance points taken off for: Chemical purity (15).  $100 - 15 = 85$

	<b>Giddings 1990</b>	<b><i>R. subcapitata</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Protocol for conducting 5-day toxicity tests with freshwater and/or marine algae following FIFRA guideline 122-2 and 123-2	
Phylum/subphylum	Chlorophyta	
Class	Chlorophyceae	
Order	Sphaeropleales	
Family	Selenastraceae	
Genus	<i>Raphidocelis</i>	
Species	<i>subcapitata</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	4 d	
Source of organisms	Carolina Biological Supply Company, Burlington, North Carolina	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	4 d, yes	
Animals randomized?	Not reported	Given nature of organism, aliquots of stock culture are assumed randomly taken
Test vessels randomized?	Not reported	
Test duration	120 h	
Data for multiple times?	24, 48, 72, 96, 120 h	
Effect 1:	Cell count	
Control response 1, x $10^4$ cells/mL, mean (negative; solvent)	24 h: 4 48 h: 11	

	<b>Giddings 1990</b>	<b><i>R. subcapitata</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
	72 h: 24 96 h: 65 120 h: 88	
Temperature	25 ± 1 °C	
Test type	Static	
Photoperiod/light intensity	Continuous/3500-5000 lux	
Dilution water	Growth medium	Marine Biological Medium prepared with deionized water
pH	7.5	
Feeding	Growth medium	
Purity of test substance	71.5 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	93-160 %	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC	
Concentration of carrier (if any) in test solutions	Acetone: 0.1 mL/L	
Concentration 1 Nom; Meas (µg/L)	0.20; 0.32	3 reps, 2700 cells/rep  900 µL at 0.3 x 10 <sup>4</sup> cells/mL
Concentration 2 Nom; Meas (µg/L)	0.42; 0.39	3 reps, 2700 cells/rep
Concentration 3 Nom; Meas (µg/L)	0.80; 0.78	3 reps, 2700 cells/rep
Concentration 4 Nom; Meas (µg/L)	1.6; 1.7	3 reps, 2700 cells/rep
Concentration 5 Nom; Meas (µg/L)	3.2; 3.6	3 reps, 2700 cells/rep
Control 1 Nom; Meas (µg/L)	Negative: 0; 0	3 reps, 2700 cells/rep
Control 2 Nom; Meas (µg/L)	Solvent: 0; 0	3 reps, 2700 cells/rep
EC <sub>50</sub> (95% CI) (µg/L)	120 h: 0.35 (0.33 – 0.37)	Method: linear regression
NOEC	0.32	Method: ANOVA and Dunnett's procedure p: 0.05 MSD: not reported

	<b>Giddings 1990</b>	<b><i>R. subcapitata</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Effect 1: % control at NOEC	120 h: 94 %	83 (tmt) / 88 (mean controls) = 94 %

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points were not taken off for water quality parameters (hardness, alkalinity, conductivity) because there is no guidance for these parameters in the test guidelines for algal/plant studies, the growth medium used requires distilled water, and the medium is presumably appropriate for the test species because a specific culture media was used.

Reliability points taken off for:

Documentation: Statistical significance (2), Minimum significant difference (2). Total: 100-4=96

Acceptability: Chemical purity (10), Minimum significant difference (1), % control at LOEC (1). Total: 100-12 = 88

**Reliability score: mean(96,88)=92**

## Water Toxicity Data Summary

### *Skeletonema costatum*

Study: Giddings, J.M. 1990. Goal technical—toxicity to five species of aquatic plants. Springborn Laboratories, Inc., Wareham, Massachusetts. Reports # 90-08-3417. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 41618401.

#### Relevance

Score: 85

Rating: L

#### Reliability

Score: 88

Rating: R

Relevance points taken off for: Chemical purity (15).  $100 - 15 = 85$

	<b>Giddings 1990</b>	<b><i>S. costatum</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Test method cited	Protocol for conducting 5-day toxicity tests with freshwater and/or marine algae following FIFRA guideline 122-2 and 123-2	
Phylum	Bacillariophyta	
Class/subclass	Coscinodiscophyceae/ Thalassiosirophycidae	
Order	Thalassiosirales	
Family	Skeletonemaceae	
Genus	<i>Skeletonema</i>	
Species	<i>costatum</i>	
Family native to North America?	Yes	
Age/size at start of test/growth phase	5 d	
Source of organisms	Carolina Biological Supply Company, Burlington, North Carolina	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	5 d, yes	
Animals randomized?	Not reported	Given organism size and presence in growth medium, it is assumed that aliquots are inherently randomly
Test vessels randomized?	Yes	
Test duration	120 h	
Data for multiple times?	24, 48, 72, 96, 120 h	
Effect 1:	Cell count	

	<b>Giddings 1990</b>	<b><i>S. costatum</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
Control response 1, x 10 <sup>4</sup> cells/mL, mean (negative; solvent)	24 h: 8 48 h: 21 72 h: 87 96 h: 142 120 h: 207	
Temperature	21 ± 1 °C	
Test type	Static	
Photoperiod/light intensity	16l : 8 d/4000-5000 lux	
Dilution water	Growth medium	Algal Assay Procedure medium prepared with deionized water
pH	7.5	
Feeding	Growth medium	
Purity of test substance	71.5 %	
Concentrations measured?	Yes	
Measured is what % of nominal?	Not calculable	
Toxicity values calculated based on nominal or measured concentrations?	Measured	
Chemical method documented?	GC	
Concentration of carrier (if any) in test solutions	Acetone: 0.1 mL/L	
Concentration 1 Nom; Meas (µg/L)	0.30; not reported	3 reps, 6400 cells/rep  640 µL at 1.0 x 10 <sup>4</sup> cells/mL
Concentration 2 Nom; Meas (µg/L)	0.60; not reported	3 reps, 6400 cells/rep
Concentration 3 Nom; Meas (µg/L)	1.3; not reported	3 reps, 6400 cells/rep
Concentration 4 Nom; Meas (µg/L)	2.5; not reported	3 reps, 6400 cells/rep
Concentration 5 Nom; Meas (µg/L)	5.0; not reported	3 reps, 6400 cells/rep
Control 1 Nom; Meas (µg/L)	Negative: 0; 0	3 reps, 6400 cells/rep
Control 2 Nom; Meas (µg/L)	Solvent: 0; 0	3 reps, 6400 cells/rep
EC <sub>50</sub> (95% CI) (µg/L)	3.3 (1.1 – 5.8)	Method: linear regression
NOEC	2.5	Method: ANOVA and Dunnett's Procedure

	<b>Giddings 1990</b>	<b><i>S. costatum</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
		p: 0.05 MSD: not reported
Effect 1: % control at NOEC	74 %	153 (tmt) / 207 (mean controls) = 74 %

Notes:

Solubility (S) of oxyfluorfen = 176.8 µg/L, 2S = 353.6 µg/L. All exposure concentrations were below 2S and where therefore acceptable.

Reliability points were not taken off for water quality parameters (hardness, alkalinity, conductivity) because there is no guidance for these parameters in the test guidelines for algal/plant studies, the growth medium used requires distilled water, and the medium is presumably appropriate for the test species because a specific culture media was used.

Reliability points taken off for:

Documentation: Measured concentrations (3), Statistical significance (2), Minimum significant difference (2). Total: 100- 7=93

Acceptability: Chemical purity (10), Measured concentrations within 20% nominal (4), Minimum significant difference (1), % control at NOEC (1), % control at LOEC (1). Total: 100- 17 = 83

**Reliability score: mean(93,83)=88**



## **Appendix A4 – Wildlife Toxicity Studies Rated L**

Table 3.10 Documentation and acceptability rating for terrestrial laboratory/field data (adapted from ECOTOX 2006). Score is given if parameter is reported.

Parameter <sup>1</sup>	Score <sup>2</sup>	Points
Exposure duration	20	<b>20</b>
Control type	7	<b>7</b>
Organism information (i.e., age, life stage)	8	<b>8</b>
Chemical grade or purity	5	<b>5</b>
Chemical analysis method	5	<b>0</b>
Exposure type (i.e., dermal, dietary, gavage)	10	<b>10</b>
Test location (i.e., laboratory, field, natural artificial)	5	<b>5</b>
Application frequency	5	<b>5</b>
Organism source	5	<b>5</b>
Organism number and/or sample number	5	<b>5</b>
Dose number	5	<b>0</b>
Statistics		
Hypothesis tests		
Statistical significance	5	<b>0</b>
Significance level	5	<b>0</b>
Minimum significant difference	3	<b>0</b>
% of control at NOEC and/or LOEC	3	<b>0</b>
Point estimates (i.e., LC <sub>50</sub> , EC <sub>50</sub> )	4	<b>0</b>
Total	100	<b>70</b>

<sup>1</sup> Compiled from RIVM (2001), USEPA (1985; 2003b), ECOTOX (2006), CCME (1999), ANZECC & ARMCANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

<sup>2</sup> Weighting based acceptability criteria from various ASTM, OECD, APHA, and USEPA methods, ECOTOX (2006), and on data quality criteria in RIVM (2001), USEPA (1985; 2003b), CCME (1999), ANZECC & ARMCANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

Notes: Oxyfluorfen has the potential to bioaccumulate because its log K<sub>ow</sub> > 3 (4.68). However, it is not possible to calculate *NOEC<sub>water</sub>* for this study because no *NOEC<sub>oral-predator</sub>* was calculated in this study. The study found no adverse effects for any measured response metric.

$$NOEC_{water} = \frac{NOEC_{oral-predator}}{BCF_{food\_item} \cdot BMF_{food\_item}}$$

## **Appendix A5 – Aqueous studies rated N**

## Water Toxicity Data Summary

### *Anabena flos-aquae*

Study: Giddings, J.M. 1990. Goal technical—toxicity to five species of aquatic plants. Springborn Laboratories, Inc., Wareham, Massachusetts. Reports # 90-08-3417. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 41618401.

**EC<sub>50</sub> and NOEC values exceeded >2S so study rates N and cannot be used for criteria derivation.**

## Water Toxicity Data Summary

### *Chlorella pyrenoidosa*

Study: J. Ma, W. Liang, L. Xu, S. Wang, Y. Wei, J. Lu . 2001. Acute Toxicity of 33 Herbicides to the Green Alga *Chlorella pyrenoidosa*. Bull. Environ. Contam. Toxicol. 66:536–541.

#### Relevance

Score:

Rating: N

#### Reliability

Score: 38.5

Rating: N

**EC<sub>50</sub> (4,008 µg/L) exceeds 2S (353.6 µg/L) so study rates N and cannot be used in criteria derivation.**

## Water Toxicity Data Summary

### *Cyprinodon variegatus*

Study: Graves, W.C., Peters, G.T. 1990. Goal technical herbicide: a 96-hour static acute toxicity test with the sheepshead minnow (*Cyprinodon variegatus*). Wildlife International, Ltd. Project number 129A-101. Rohm and Haas report number 90RC-0009. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. Wildlife International, Ltd., Easton, Maryland. EPA MRID 41698801.

**LC<sub>50</sub> (100,000 µg/L) exceeds 2S (353.6 µg/L) and therefore rates N and cannot be used in criteria derivation.**

## Water Toxicity Data Summary

### *Crassostrea virginica*

Study: Vilkas, A.G. 1977. The acute toxicity of RH 2915 technical, lot # 7364 (74 % active ingredient) to the eastern oyster, *Crassostrea virginica*. Union Carbide Environmental Services, Tarrytown, New York. Project number 11506-33-02. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 134453.

**Acute study endpoint not related to survival and study only tested a single concentration so it automatically rates N and cannot be used for criteria derivation.**

## Water Toxicity Data Summary

### *Chlorella vulgaris*

Study: Ma, J., Xu, L., Wang, S., Zheng, R., Jin, S., Huang, S., & Huang, Y. 2002. Toxicity of 40 herbicides to the green alga *Chlorella vulgaris*. Ecotoxicology and environmental safety, 51(2), 128-132.

#### Relevance

Score: not scored

Rating: not rated

#### Reliability

Score: not scored

Rating: not rated

**LC<sub>50</sub> (1488.8) exceeds 2S (353.6 µg/L) so study rates N and cannot be used in criteria derivation.**



## Water Toxicity Data Summary

### *Daphnia magna*

Study: Forbis, A., Frazier, S. 2001. Goal technical herbicide: acute aquatic toxicity study in *Daphnia magna*—supplemental to Report 86RC-014A, MRID #92136106. Analytical Bio-Chemistry Labs, Columbia, Missouri. ABC study number 033943. Submitted to Dow Agrosciences LLC. Dow Agrosciences study ID 86RC-014D. EPA MRID 45550201.

**Handwritten laboratory data sheets and typed protocol only. Cannot confirm all aspects in protocol were performed. Therefore the study rates N and will not be used in criteria derivation.**

## Water Toxicity Data Summary

### *Daphnia magna*

Study: LeBlanc, GA. 1976. Acute toxicity of RH-2195 to *Daphnia Magna*. Bioassay report submitted to Rohm and Haas Company, Spring House, Pennsylvania. EG&G Bionomics, Aquatic Toxicology Laboratory, Wareham, Massachusetts. EPA MRID 134449.

#### Relevance

Score: not scored

Rating:

#### Reliability

Score: not scored

Rating:

**LC<sub>50</sub> (4700 µg/L) exceeds 2S (353.6 µg/L) and therefore rates N and cannot be used in criteria derivation.**

## Water Toxicity Data Summary

### *Elliptio complanta*

Study: Godfrey, W.J., Longacre, S.L. 1990. Phase 3 summary of MRID 00134452 Goal technical herbicide oxyfluorfen acute toxicity to the freshwater clam. Union Carbide Corporation, Tarrytown, New York. Laboratory project number 11506-33-02. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 92136009.

**LC<sub>50</sub> (9600) exceeds 2S (353.6 µg/L) so study rates N and cannot be used in criteria derivation**

## Water Toxicity Data Summary

### *Elliptio complanata*

Study: Vilkas, A.G. 1977. Acute toxicity of RH 2915 technical, lot # 7364 (74 % active ingredient) to the freshwater clam, *Elliptio complanata*. Union Carbide Environmental Services, Tarrytown, New York. Project number 11506-33-02. Submitted to Rohm and Haas Company, Spring House, Pennsylvania. EPA MRID 134452.

**LC<sub>50</sub> > 2S so study rates N and cannot be used for criteria derivation.**

## Water Toxicity Data Summary

*Oncorhynchus mykiss*

Study: Bentley, Robert E. 1973. Acute toxicity of RH-2915 to bluegill (*Lepomis macrochirus*) and rainbow trout (*Salmo gairdneri*). Bionomics, Inc., Wareham, MA. Submitted to Rohm & Haas Company, Bristol, PA. CDPR study ID 2975.

Relevance

Score: 100

Rating: R

Reliability

Score: 79

Rating: R

**LC<sub>50</sub> exceeds (410 µg/L ) 2S (353.6 µg/L) so study cannot be used in criteria derivation.**

## Water Toxicity Data Summary

### *Scenedesmu obliquus*

Study: Geoffroy L, Dewez D, Vernet G, Popovic R. 2003. Oxyfluorfen toxic effect on *S. obliquus* evaluated by different photosynthetic and enzymatic biomarkers. Arch Environ Contam Toxicol. 45(4):445-52.

#### Relevance

Score: 55

Rating: N

#### Reliability

Score: 55

Rating: N

Relevance points taken off for: Chemical purity (15), toxicity value (15), controls (15)

	Geoffroy et al. 2003	<i>S. obliquus</i>
Parameter	Value	Comment
Test method cited	No	
Phylum/subphylum	Chlorophyta	
Class	Chlorophyceae	
Order	Sphaeropleales	
Family	Scenedesmaceae	
Genus	<i>Scenedesmus</i>	
Species	<i>obliquus</i>	
Family native to North America?	Yes, ubiquitous	
Age/size at start of test/growth phase	Exponential	
Source of organisms	External lab, strain stated	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Acclimated, not tested for disease	
Animals randomized?	Not stated	
Test vessels randomized?	Not stated	
Test duration	48 h	Time intervals after exposure stated: 12, 24, 48 h
Data for multiple times?	Yes, 12, 24, 48 h	Times = separate treatments
Effect 1	Growth	
Control response 1		Control data not reported
Temperature	28 ± 1 °C	USEPA OPPTS 850.5400 states 24 or 20 ± 2 °C, depending on species
Test type	Static	
Photoperiod/light intensity	continuous illumination	USEPA OPPTS

	<b>Geoffroy et al. 2003</b>	<b><i>S. obliquus</i></b>
<b>Parameter</b>	<b>Value</b>	<b>Comment</b>
	(110± 10 µmoles of photons.m <sup>-2</sup> s <sup>-1</sup> )	850.5400 states light/dark cycles
Dilution water	No, growth medium	
pH	Not reported for growth tests	
Hardness	Not reported	
Alkalinity	Not reported	
Conductivity	Not reported	
Dissolved Oxygen	Not reported	
Feeding	Single initial feeding via placement in growth medium	
Purity of test substance	Not reported	
Concentrations measured?	Not measured	
Measured is what % of nominal?	Not reported	
Toxicity values calculated based on nominal or measured concentrations?	Nominal	
Chemical method documented?	Cytometer cell count at 480 nm	
Concentration of carrier (if any) in test solutions		
Concentration 1 Nom; Meas (µg/L)	7.5, n/a	≥3 reps, 2 10 <sup>6</sup> cells mL <sup>-1</sup> /rep
Concentration 2 Nom; Meas (µg/L)	1.5E1, n/a	≥3 reps, 2 10 <sup>6</sup> cells mL <sup>-1</sup> /rep
Concentration 3 Nom; Meas (µg/L)	2.25E1, n/a	≥3 reps, 2 10 <sup>6</sup> cells mL <sup>-1</sup> /rep
Control	Solvent only	≥3 reps, 2 10 <sup>6</sup> cells mL <sup>-1</sup> /rep
LC <sub>50</sub> (95% CI) (µg/L)	Not reported	Method:
EC <sub>50</sub> (95% CI) (µg/L)	Not reported	Method:
NOEC	Not reported	Method: p: MSD:
LOEC	Not reported	
MATC (GeoMean NOEC, LOEC)	Not reported	
% control at NOEC	Not reported	
% control at LOEC	Not reported	

Notes: Concentrations affecting growth were not reported. Growth was only one of many tested effects in this study.

Solubility (S) = 1.958E2 µg/L, 2S = 3.916 µg/L so all exposures are acceptable.

Reliability points taken off for:

Documentation: Chemical purity (5), Analytical method (4), Measured concentrations (3), Dilution water (3), Hardness (2), Alkalinity (2), Dissolved oxygen (4), Conductivity (2), pH (3), Minimum significant difference (2), % control at NOEC/LOEC (2), Point estimates (8). Total: 100- 40=60

Acceptability: Standard method (5), Chemical purity (10), Measured concentrations within 20% nominal (4), Organisms randomized (1), Dilution water (2), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Conductivity (1), pH (2), Number of concentrations (3), Random design (2), Adequate replication (2), Statistical method (2), Minimum significant difference (1), % control at NOEC (1), % control at LOEC (1), LC/EC values (3). Total: 100- 50=50

Reliability score:  $\text{mean}(60,50)=55$



## **Appendix A6 – Wildlife studies rated N**

*Anas platyrhynchos*. Fletcher, D. 1987. USEPA study ID 42142303.

Table 3.10 Documentation and acceptability rating for terrestrial laboratory/field data (adapted from ECOTOX 2006). Score is given if parameter is reported.

**Notes: LC<sub>50</sub> reported to be in excess of 5000 ppm (5,000,000 µg/L), which is >2S of oxyfluorfen. Studies with LC<sub>50</sub> > 2S rate N and cannot be used for criteria derivation.**

Parameter <sup>1</sup>	Score <sup>2</sup>	Points
Exposure duration	20	<b>20</b>
Control type	7	<b>7</b>
Organism information (i.e., age, life stage)	8	<b>8</b>
Chemical grade or purity	5	<b>5</b>
Chemical analysis method	5	<b>0</b>
Exposure type (i.e., dermal, dietary, gavage)	10	<b>10</b>
Test location (i.e., laboratory, field, natural artificial)	5	<b>5</b>
Application frequency	5	<b>5</b>
Organism source	5	<b>5</b>
Organism number and/or sample number	5	<b>5</b>
Dose number	5	<b>5</b>
Statistics		
Hypothesis tests		
Statistical significance	5	<b>0</b>
Significance level	5	<b>0</b>
Minimum significant difference	3	<b>0</b>
% of control at NOEC and/or LOEC	3	<b>0</b>
Point estimates (i.e., LC <sub>50</sub> , EC <sub>50</sub> )	4	<b>0</b>
Total	100	<b>75</b>

<sup>1</sup> Compiled from RIVM (2001), USEPA (1985; 2003b), ECOTOX (2006), CCME (1999), ANZECC & ARMICANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

<sup>2</sup> Weighting based acceptability criteria from various ASTM, OECD, APHA, and USEPA methods, ECOTOX (2006), and on data quality criteria in RIVM (2001), USEPA (1985; 2003b), CCME (1999), ANZECC & ARMICANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

*Anas platyrhynchos*. Godfrey, W.J., Longacre, S.L. 1990. USEPA study ID 92136092.

Table 3.10 Documentation and acceptability rating for terrestrial laboratory/field data (adapted from ECOTOX 2006). Score is given if parameter is reported.

**Notes: LC<sub>50</sub> reported to be in excess of 5000 ppm (5,000,000 µg/L), which is >2S of oxyfluorfen. Studies with LC<sub>50</sub> > 2S rate N and cannot be used for criteria derivation.**

Parameter <sup>1</sup>	Score <sup>2</sup>	Points
Exposure duration	20	<b>20</b>
Control type	7	<b>7</b>
Organism information (i.e., age, life stage)	8	<b>8</b>
Chemical grade or purity	5	<b>5</b>
Chemical analysis method	5	<b>0</b>
Exposure type (i.e., dermal, dietary, gavage)	10	<b>10</b>
Test location (i.e., laboratory, field, natural artificial)	5	<b>5</b>
Application frequency	5	<b>5</b>
Organism source	5	<b>5</b>
Organism number and/or sample number	5	<b>5</b>
Dose number	5	<b>5</b>
Statistics		
Hypothesis tests		
Statistical significance	5	<b>0</b>
Significance level	5	<b>0</b>
Minimum significant difference	3	<b>0</b>
% of control at NOEC and/or LOEC	3	<b>3</b>
Point estimates (i.e., LC <sub>50</sub> , EC <sub>50</sub> )	4	<b>0</b>
Total	100	<b>78</b>

<sup>1</sup> Compiled from RIVM (2001), USEPA (1985; 2003b), ECOTOX (2006), CCME (1999), ANZECC & ARMICANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).

<sup>2</sup> Weighting based acceptability criteria from various ASTM, OECD, APHA, and USEPA methods, ECOTOX (2006), and on data quality criteria in RIVM (2001), USEPA (1985; 2003b), CCME (1999), ANZECC & ARMICANZ (2000), OECD (1995), and Van Der Hoeven et al. (1997).